



U.S. Department  
of Transportation

**Federal Highway  
Administration**

# Specifications for the National Tunnel Inventory



**May 2013**

## FOREWORD

This document was developed in conjunction with the National Tunnel Inspection Standards (NTIS) and the Tunnel Operations, Maintenance, Inspection and Evaluation Manual (TOMIE). It is intended to supplement the NTIS and provide the specifications for coding data to be submitted to the National Tunnel Inventory (NTI). Data in the NTI will be used to meet legislative reporting requirements and provide the public with information on the number and condition of the Nation's tunnels.

First, we have to acknowledge the initial work done through a joint project between the Federal Highway Administration and the Federal Transit Authority to develop the Highway and Rail Transit Tunnel Inspection Manual in 2003, which was updated in 2005. This document laid the foundation for tunnel inspections on highways using a general condition rating methodology. Just as the inspection needs for bridges have evolved over the years, so to have the inspection needs for tunnels. In this coding document, we move from general condition ratings to element condition states. By moving to element condition states, tunnel owners are able to more easily integrate tunnel inventory data into an asset management program for maintenance and repairs of their tunnels.

We would like to acknowledge those who were involved in the development of this specification, HDR, Bentley, AASHTO T-20 members and the FHWA Review Team.

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# **Specifications for the National Tunnel Inventory**

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# Table of Contents

<b>Section 1—Introduction.....</b>	<b>5</b>
1.1—History.....	6
1.2—Purpose of the Specifications .....	6
1.3—Organization of the Specifications .....	7
1.4—Units.....	8
1.5—Definitions .....	8
1.6—Acronyms.....	9
<b>Section 2—Inventory Items .....</b>	<b>11</b>
2.1—Introduction .....	12
2.2—Identification Items.....	14
2.3—Age and Service Items.....	30
2.4—Classification Items.....	37
2.5—Geometric Data Items .....	44
2.6—Inspection Items.....	49
2.7—Load Rating and Posting Items.....	53
2.8—Navigation Items .....	63
2.9—Structure Type and Material Items.....	67
<b>Section 3—Elements.....</b>	<b>72</b>
3.1—Introduction .....	73
3.2—Structural Section .....	75
3.3—Civil Section .....	135
3.4—Mechanical Systems Section.....	145
3.5—Electrical Systems Section .....	152
3.6—Lighting Systems Section .....	155
3.7—Fire/Life Safety/Security Systems Section.....	160
3.8—Signs Section.....	165
3.9—Protective Systems Section .....	171
<b>Index of Inventory Items and Elements.....</b>	<b>175</b>
Inventory Items.....	175
Elements .....	177
<b>Appendix A: Tunnel Coding Example .....</b>	<b>181</b>
<b>References.....</b>	<b>191</b>

# **Section 1—Introduction**

**Section 1.1—History**

**Section 1.2—Purpose of the Specifications**

**Section 1.3—Organization of the Specifications**

**Section 1.4—Units**

**Section 1.5—Definitions**

**Section 1.6—Acronyms**

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## **1.1—History**

Following the tragic ceiling collapse in the Interstate 90 Connector Tunnel in Boston, Massachusetts on July 10, 2006, the National Transportation Safety Board's Highway Accident Report, NTSB Number HAR-07/02, identified several safety issues including, "*Inadequate regulatory requirements for tunnel inspections*". On July 6, 2012, the President signed the Moving Ahead for Progress in the 21<sup>st</sup> Century Act (MAP-21), which requires the Secretary to establish national standards for tunnel inspections. Recognizing that the safety and security of our Nation's tunnels are of paramount importance, and as a result of the legislative mandate in MAP-21, FHWA established the National Tunnel Inspection Standards and corresponding manuals and guides to accomplish the inspections.

The proper inventory and assessment of the condition of highway tunnel elements is the cornerstone of sound tunnel management. The introduction of element assessment methods in the early 1990s represented a significant advancement in infrastructure inspection practice and has been adopted by the vast majority of all State Transportation Departments in the United States for bridges. Bridge owners nationwide have recognized the benefits of detailed condition assessments through the use of the raw inspection information, expanded performance measures, and bridge management system deterioration forecasting and evaluation. As the use of element level inspection techniques has proliferated, the need to include highway tunnels has been identified. These specifications incorporate tunnel elements including: structural, civil, mechanical systems, electrical systems, lighting systems, fire/life safety/security systems, signs, and protective systems. The goal of these specifications is to comprehensively layout how to inventory and document the condition of tunnels in a way that can be standardized across the nation while providing the flexibility to be adapted to both large and small agency settings. These specifications are not intended to supplant proper training or the exercise of sound engineering judgment by the inspector and/or professional engineer.

The FHWA Specifications for the National Tunnel Inventory builds on the element level condition assessment methods originally developed in the AASHTO Guide for Commonly Recognized Structural Elements and recently improved in the AASHTO Guide Manual for Bridge Element Inspections. The multi-path distress language provides the means to incorporate defects within the overall condition assessment of the element. The overall condition of an element can be utilized in this aggregate form, or broken down into specific defects present as desired by the agency for Tunnel Management System (TMS) use. The complete set of elements capture the components necessary for an agency to manage all aspects of the tunnel inventory utilizing the full capability of a TMS.

## **1.2—Purpose of the Specifications**

These specifications have been prepared for use by State, Federal and other agencies in recording and coding data elements that will comprise the National Tunnel Inventory. By having a complete and thorough inventory, an accurate report can be made to Congress on the number and condition of the Nation's highway tunnels.

The coded items in these specifications are considered to be an integral part of the database that can be used to meet several Federal reporting requirements, as well as part of the States' needs. These requirements are set forth in the National Bridge and Tunnel Inventory and Inspection Standards (Section 144 of Title 23, United States Code). A complete, thorough, accurate and compatible database is the foundation of an effective tunnel management system.

The FHWA Tunnel Operations, Maintenance, Inspection and Evaluation (TOMIE) Manual discussed the various items of information that are to be recorded as part of original tunnel reports. That Manual discusses inspection procedures and the preparation of detailed reports about the tunnel elements. These reports will be the basis for the recording values for many of the data elements shown in the Specifications.

State, Federal and other agencies are encouraged to use the codes and instructions in these Specifications. However, its direct use is optional; each agency may use its own code scheme provided that the data are directly translatable into the Specifications format. When data are requested by FHWA, the format will be based on the codes and instructions in these Specifications. An agency choosing to use its own codes shall provide for translation or conversion of its own codes into those used by these Specifications. In other words, agencies are responsible for having the capability to obtain, store and report certain information about highway tunnels whether or not these Specifications are used. Any requests by FHWA for submittals of these data will be based on the definitions, explanations, and codes supplied in the Specifications and the TOMIE Manual.

### 1.3—Organization of the Specifications

The FHWA Specifications for the National Tunnel Inventory are organized into the following Sections:

**Section 1 (*Introduction*)** is comprised of subsections devoted to History, Purpose of the Specifications, Organization of the Specifications, Units, Definitions and Acronyms.

**Section 2 (*Inventory Items*)** is comprised of tunnel inventory items (Identification, Age and Service, Classification, Geometric Data, Inspection, Load Rating and Posting, Navigation, and Structure Type & Material) by category to facilitate ease of use by tunnel inspectors in the field.

**Section 3 (*Elements*)** is comprised of tunnel elements (Structural, Civil, Mechanical Systems, Electrical Systems, Lighting Systems, Fire/Life Safety/Security Systems, Signs, and Protective Systems) by general element type, material, and in accordance to their physical location in the tunnel to facilitate ease of use by tunnel inspectors in the field.

**Index of Inventory Items and Elements** is a list of all of the items and elements in this Specification from Sections 2 and 3.

### Appendix A

## Appendix B

### References

#### 1.4—Units

Throughout the Specifications, all units are referenced as English units.

#### 1.5—Definitions

American Association of State Highway and Transportation Officials (AASHTO) Manual. “The Manual for Bridge Evaluation,” as published by the American Association of State Highway and Transportation Officials as incorporated by reference in the NBIS, see § 650.317.

At-grade roadway. Paved or unpaved travel ways within the tunnel that carry vehicular traffic and are not suspended or supported by a structural system.

Complex tunnel. A tunnel characterized by advanced or unique structural elements or functional systems.

Damage inspection. This is an unscheduled inspection to assess structural damage resulting from environmental factors or human actions.

Functional systems. Non-structural systems, such as electrical, mechanical, fire suppression, ventilation, lighting, communications, monitoring, draining, traffic signals, emergency response (including egress, refuge room spacing, or carbon monoxide detection), or other traffic safety components.

Hands-on. Inspection within arms length of the component. Inspection uses visual techniques that may be supplemented by nondestructive testing.

In-depth inspection. A close-up inspection of one, several, or all tunnel structural elements or functional systems to identify any deficiencies not readily detectable using routine inspection procedures; hands-on inspection may be necessary at some locations. In-depth inspections may occur more or less frequently than routine inspections, as outlined in the tunnel-specific inspection procedures.

Initial inspection. The first inspection of a tunnel to provide all inventory and appraisal data and to determine the condition baseline of the structural and functional systems.

Legal load. The maximum legal load for each vehicle configuration permitted by law for the State in which the tunnel is located.

Load rating. The determination of the live load carrying capacity within or above the tunnel using structural plans and supplemented by information gathered from a routine, in-depth or special inspection.

National Tunnel Inventory (NTI). The aggregation of structure inventory and appraisal data collected to fulfill the requirements of the National Tunnel Inspection Standards. Each State shall prepare and maintain an inventory of all tunnels subject to the NTIS.

National Tunnel Inspection Standards (NTIS). Federal regulations establishing requirements for inspection procedures, frequency of inspections, qualification of personnel, inspection reports, and preparation and maintenance of a State tunnel inventory. The NTIS apply to all structures defined as tunnels located on all public roads.

Portal. The entrance and exit of the tunnel exposed to the environment; portals may include bare rock, constructed tunnel entrance structure, or buildings.

Routine inspection. A regularly scheduled comprehensive inspection encompassing all tunnel structural elements and functional systems and consisting of observations and measurements needed to determine the physical and functional condition of the tunnel, to identify any changes from initial or previously recorded conditions, and to ensure that tunnel components continue to satisfy present service requirements.

Special inspection. An inspection, scheduled at the discretion of the tunnel owner, used to monitor a particular known or suspected deficiency.

Tunnel. An enclosed roadway for motor vehicular traffic with vehicle access limited to portals, regardless of type of structure or method of construction. Tunnels do not include bridges or culverts inspected under the National Bridge Inspection Standards (23 CFR 650 – Subpart C – National Bridge Inspection Standards). Tunnels are structures that require, based on owner's determination, special design considerations that may include lighting, ventilation, fire protection systems, and emergency egress capacity.

## **1.6—Acronyms**

AASHTO – American Association of State Highway and Transportation Officials

ADT – Average Daily Traffic

ADTT – Average Daily Truck Traffic

AS – Allowable Stress

ASD – Allowable Stress Design

CALTRANS – California Department of Transportation

FHWA – Federal Highway Administration

FIPS – Federal Information Processing Standard (standard codes for States)

HAR – Highway Accident Report

HPMS – Highway Performance Monitoring System

ID - Identification

LF – Load Factor

LFD – Load Factor Design

LRFR – Load and Resistance Factor Rating

LRS – Linear Referencing System (spatial coordinate system)  
NASA – National Aeronautics and Space Administration  
NHS – National Highway System  
NTI – National Tunnel Inventory  
NTIS – National Tunnel Inspection Standards  
NTSB – National Transportation Safety Board  
PennDOT – Pennsylvania Department of Transportation  
RF – Rating Factor  
STRAHNET – Strategic Highway Network  
TOMIE – Tunnel Operations, Maintenance, Inventory and Evaluation Manual

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## **Section 2—Inventory Items**

**Section 2.1—Introduction**

**Section 2.2—Identification Items**

**Section 2.3—Age and Service Items**

**Section 2.4—Classification Items**

**Section 2.5—Geometric Data Items**

**Section 2.6—Inspection Items**

**Section 2.7—Load Rating and Posting Items**

**Section 2.8—Navigation Items**

**Section 2.9—Structure Type and Material Items**

## 2.1—Introduction

This section is comprised of tunnel inventory items arranged by category to facilitate ease of use by tunnel inspectors in the field.

Inventory Item Name			
<u>Format</u> XX			<u>Item ID</u> A.#
Specification		Commentary	
Detailed description of requirements for each inventory item.		A series of explanations for each inventory item.	
Examples			
Example Description		Example Coding	

The format of an item is broken into 6 parts: (1) Inventory Item Name, (2) Format, (3) Item ID, (4) Specification, (5) Commentary and (6) Examples.

The Inventory Item Name is the name used to describe that particular item.

The Format details how the item should be coded by using one of following four descriptions and lengths:

- AN (Alpha Numeric with either a number or unlimited)
  - AN3 is an example of an alpha numeric with a limit of 3 characters
  - AN-unlimited is an example of an alpha numeric with unlimited character length
  - Leading 0's are required for alpha numeric when limited by a number
- N# (Numeric where # is the length of the field)
  - N2 is an example of a numerical value, such as 01
  - Leading 0's are required for numeric formats
- FP (X,Y) (Floating Point where X is the length of the number and Y is the number of decimals)
  - FP(5,1) is an example of a floating point, such as 1016.1
  - Leading 0's are not required for floating point formats
- D (Date recorded as MMYYY)
  - D is an example of a date, such as 0213

The Item ID is a unique indicator assigned to each tunnel item, it is a letter followed by a number. Inventory items are identified by a letter based on the section and a number based on the order of appearance in that section. Identification items are identified with an “I”, Age and Service items are identified with an “A”, Classification items with a “C”, Geometric Data items with a “G”, Inspection items with a “D”, Load Rating and Posting items with a “L”, Navigation items with “N”, and Structure Type & Material items with a “S”.

The Specifications and Commentary portions provide the detailed description of each inventory item and some explanation or additional clarification to consider for coding each item.

The Example portion provides examples of how to code the item when compared to certain situations.

## 2.2—Identification Items

### Identification Items

The items in this section uniquely identify and locate the tunnel.

#### Item ID

- I.1 Tunnel Number
- I.2 Tunnel Name
- I.3 State Code
- I.4 County Code
- I.5 Place Code
- I.6 Highway Agency District
- I.7 Route Number
- I.8 Route Direction
- I.9 Route Type
- I.10 Facility Carried
- I.11 LRS Route ID
- I.12 LRS Mile Point
- I.13 Tunnel Portal's Latitude
- I.14 Tunnel Portal's Longitude
- I.15 Border Tunnel State or Country Code
- I.16 Border Tunnel Financial Responsibility
- I.17 Border Tunnel Number
- I.18 Border Tunnel Inspection Responsibility

<b><i>Tunnel Number</i></b>			
<u>Format</u> AN15			<u>Item ID</u> I.1
Specification		Commentary	
<p>Record the unique tunnel number assigned according to agency policy for each tunnel meeting the NTIS Definition.</p> <p>Do not change the tunnel number once it has been assigned and recorded.</p>		<p>There are no national policies established for assigning unique tunnel numbers. Therefore, each State Transportation Department or Federal agency develops their own policy for assigning unique tunnel numbers.</p> <p>It is preferable that one tunnel number be assigned to tunnels with multiple bores including ramps where they are connected, such as those sharing ventilation systems, etc.</p> <p>When recording separate Tunnel Numbers for tunnels carrying multiple bores it is recommended to append the tunnel number with “L”, “C” or “R” looking stations ahead, where L=left, C=center, and R=right.</p> <p>Consult the local FHWA Division office for questions concerning assigning tunnel numbers to unique or complex tunnels.</p>	

Tunnel Name			
Format AN-unlimited			Item ID I.2
Specification		Commentary	
Record the tunnel name assigned by the agency. If the tunnel is not named, leave this item blank.		There are no national policies established for assigning unique tunnel names. Therefore, each State Transportation Department or Federal agency develops their own policy for assigning unique tunnel names.  It is preferable that one tunnel name be assigned to tunnels with multiple bores.  It is recommended that this field not exceed 50 characters.	
Examples			
Tunnel Name		Code	
Squirrel Hill Tunnel		Squirrel Hill Tunnel	
Fort Pitt Tunnel		Fort Pitt Tunnel	
Blue Mountain Tunnel		Blue Mountain Tunnel	

<b>State Code</b>					
<u>Format</u> N2				<u>Item ID</u> I.3	
Specification			Commentary		
Record the State code where the tunnel is located using one of the codes in the table below.			State codes are derived from the FIPS, Standard Codes For States (FIPS PUB 5-2).		
<u>Code</u>	<u>Description</u>	<u>Code</u>	<u>Description</u>	<u>Code</u>	<u>Description</u>
01	Alabama	22	Louisiana	40	Oklahoma
02	Alaska	23	Maine	41	Oregon
04	Arizona	24	Maryland	42	Pennsylvania
05	Arkansas	25	Massachusetts	44	Rhode Island
06	California	26	Michigan	45	South Carolina
08	Colorado	27	Minnesota	46	South Dakota
09	Connecticut	28	Mississippi	47	Tennessee
10	Delaware	29	Missouri	48	Texas
11	District of Columbia	30	Montana	49	Utah
12	Florida	31	Nebraska	50	Vermont
13	Georgia	32	Nevada	51	Virginia
15	Hawaii	33	New Hampshire	53	Washington
16	Idaho	34	New Jersey	54	West Virginia
17	Illinois	35	New Mexico	55	Wisconsin
18	Indiana	36	New York	56	Wyoming
19	Iowa	37	North Carolina	72	Puerto Rico
20	Kansas	38	North Dakota		
21	Kentucky	39	Ohio		

County Code			
Format N3			Item ID I.4
Specification		Commentary	
Record the FIPS code for the county, parish or borough in which the tunnel is located.		<p>Use the FIPS codes in the current version of the Census of Population and Housing - Geographic Identification Code Scheme to determine the appropriate code.</p> <p>County, parish or borough codes can be found through a link at the following web site: <a href="http://www.itl.nist.gov/fipspubs/co-codes/states.htm">http://www.itl.nist.gov/fipspubs/co-codes/states.htm</a></p> <p>Codes for county-equivalent entities of Puerto Rico can be found in Appendix A through a link at the above web site.</p>	
Examples			
Count Code		Code	
Lincoln County, Nebraska		111	
Queens, New York		081	
Orleans Parish, Louisiana		071	

Place Code			
Format N5			Item ID I.5
Specification		Commentary	
Record the FIPS place code for the city, town, township, village, and other census-designated place where the tunnel is located.  Record 00000 if there is no FIPS place code for the tunnel's location.		Use the FIPS codes in the current version of the Census of Population and Housing - Geographic Identification Code Scheme to determine the city, town, township, village, or other census-designated place code.  FIPS place codes can be found through a link at the following web site: <a href="http://www.census.gov/geo/www/codes/place/">http://www.census.gov/geo/www/codes/place/</a>	
Examples			
Place Code		Code	
Washington, DC		50000	
Tallahassee, FL		70600	
North Platte, NE		35000	

Highway Agency District			
<u>Format</u> AN2			<u>Item ID</u> I.6
Specification		Commentary	
Record the State Transportation Department district or region number/abbreviation where the tunnel is located. Federal Agencies should record this item with their District system.		Where districts or regions are identified by number, use the existing number.  Where districts or regions are identified by name, use an abbreviated name.	
Examples			
<u>Highway Agency District</u>		<u>Code</u>	
District Six		06	
Region Two		02	
Northwest Region		NW	

Route Number			
Format AN5			Item ID I.7
Specification		Commentary	
Record the route number that represents the route carried by the tunnel.  Include letters that are used as part of the route numbers.  Do not record the route direction for divided highways. Identify that information in the route direction item.  When multiple routes use the same lane or set of lanes, complete only one Route Number for the lanes using the highest class of route based on Item ID C.7 - Functional Classification.  Code 00000 for tunnels on roads without route numbers.		When the same classification of routes exists, use the route which is of the higher order. Example of I-84 and I-205, I-84 would be coded.	
Examples			
<u>Route Number</u>		<u>Code</u>	
I-35 southbound		00035	
Undivided State Highway 9W		0009W	
I-35W southbound		0035W	
I-35 and US-77		00035	
Road without route number		00000	

Route Direction															
Format N1			Item ID I.8												
Specification		Commentary													
Record the route direction using one of the following codes for the route carried by the tunnel:  Route Direction Code <table><tr><th>Code</th><th>Description</th></tr><tr><td>0</td><td>Not a Divided Highway</td></tr><tr><td>1</td><td>North</td></tr><tr><td>2</td><td>East</td></tr><tr><td>3</td><td>South</td></tr><tr><td>4</td><td>West</td></tr></table>		Code	Description	0	Not a Divided Highway	1	North	2	East	3	South	4	West		
Code	Description														
0	Not a Divided Highway														
1	North														
2	East														
3	South														
4	West														
Examples															
<u>Route Direction</u>		<u>Code</u>													
I-35 southbound		3													
Undivided State Highway 9W		0													
I-35W southbound		3													

Route Type			
Format N1			Item ID I.9
Specification		Commentary	
Record the route type using one of the following codes:		When a roadway crosses through Federal lands such as national parks, national forests or department of defense facilities and does not meet the description of codes 1 through 5 then use code 6.	
<u>Code</u>	<u>Description</u>	When a roadway crosses through State lands such as State parks or State forests and does not meet the description of codes 1 through 5 then use code 7.	
1	Interstate highway	Ramps should be coded based on the higher class of route it connects to.	
2	U.S. numbered highway		
3	State highway		
4	County highway		
5	City street		
6	Federal lands road		
7	State lands road		
8	Other (includes toll roads not otherwise indicated above)		
When 2 or more routes are concurrent, the highest class of route will be used. The hierarchy is in the order listed above.			
Examples			
<u>Route Type</u>		<u>Code</u>	
Interstate 35 and US-77		1	
I-35 southbound		1	
Undivided State Highway 9W		3	
I-35W southbound		1	
State Highway 43 and Harlem Avenue		3	

Facility Carried			
Format AN-unlimited			Item ID I.10
Specification		Commentary	
Record the name of the facility that is carried through the tunnel.		<p>The owner may include directional or other descriptive information in this field. Official names and local names may be included.</p> <p>The name of the tunnel (i.e. Squirrel Hill Tunnel, Fort Pitt Tunnel, etc.) may be included in this item following the route name.</p> <p>It is recommended that this field not exceed 50 characters.</p>	
Examples			
<u>Facility Carried</u>		<u>Code</u>	
Interstate 90 - Massachusetts Turnpike		Interstate 90 - Massachusetts Turnpike	
Interstate 64		Interstate 64	
Aurora Avenue, SR99		Aurora Avenue, SR99	
John Hanson Highway		John Hanson Highway	
I376 – Squirrel Hill Tunnel		I376 – Squirrel Hill Tunnel	
I376 – Fort Pitt Tunnel, Inbound		I376 – Fort Pitt Tunnel, Inbound	

<b><i>LRS Route ID</i></b>			
<u>Format</u> AN60			<u>Item ID</u> I.11
Specification		Commentary	
<p>Record the linear referencing system (LRS) Route ID that identifies the roadway on which the tunnel is located. Use the LRS Route ID which has been defined by the State for the Highway Performance Monitoring System (HPMS) for reporting purposes.</p> <p>The LRS Route ID must match what is reported in HPMS. The LRS Route ID can be left blank if it is not available in HPMS.</p> <p>Not all 60 format spaces must be filled.</p>		<p>The LRS Route ID is not necessarily the same as the route number posted along the roadway, but is a number used to uniquely identify a route within at least a county and perhaps throughout the State for Geographic Information System (GIS) analysis and mapping purposes.</p>	

LRS Mile Point			
<u>Format</u> FP (8,3)			<u>Item ID</u> I.12
Specification		Commentary	
<p>Record the LRS mile point to the nearest thousandth.</p> <p>For tunnels carrying an LRS inventory route, record the mile point at the tunnel portal for which the lowest LRS Mile Point occurs.</p> <p>The LRS mile point can be left blank if it is not available in HPMS.</p>		<p>The LRS mile point is used to establish the location of the tunnel on the inventory route. The mile point must be reported in accordance with the LRS inventory route and mile point system that is used for HPMS reporting purposes.</p>	
Examples			
<u>LRS Mile Point</u>	<u>Code</u>		
130.344	130.344		
9.600	9.6		
No mile point	(blank)		

Tunnel Portal's Latitude			
Format FP (11,8)			Item ID I.13
Specification		Commentary	
Record the latitude of the tunnel portal in decimal degrees for all tunnels.  Record the latitude at the same location for the Item ID I.12 - LRS Mile Point. When Item ID I.12 - LRS Mile Point is blank, record the latitude at the tunnel portal on the edge of the right traveled way in the direction of the route at the lowest mile point.		Values recorded are assumed to be for the northern hemisphere	
Examples			
<u>Tunnel Portal's Latitude</u>		<u>Code</u>	
25° 27' 18.55"		25.45515278	
31° 5' 50.65"		31.09740278	

Tunnel Portal's Longitude			
Format FP (11,8)			Item ID I.14
Specification		Commentary	
Record the longitude of the tunnel portal in decimal degrees for all tunnels.		Values recorded are assumed to be for the northern hemisphere	
Record the longitude at the same location for the Item ID I.12 - LRS Mile Point. When Item ID I.12 - LRS Mile Point is blank, record the longitude at the tunnel portal on the edge of the right traveled way in the direction of the route at the lowest mile point.			
Examples			
Tunnel Portal's Longitude		Code	
65° 27' 18.55"		65.45515278	
75° 13' 26.69"		75.22408206	

Border Tunnel State or Country Code			
Format AN2			Item ID I.15
Specification		Commentary	
<p>Record the neighboring State's code using the codes listed in the Item ID I.3 - State Code item.</p> <p>Record this item for border tunnels when any owner within the State's geographical boundaries has some or all of the inspection, preservation, improvement or replacement responsibility.</p> <p>Record the value CN for Canada or MX for Mexico when the tunnel crosses those borders.</p> <p>Leave item blank when the tunnel does not cross a border with another State or Country or when no owner within the state's geographical boundaries has any inspection, preservation, improvement or replacement responsibility.</p>		<p>Use this item to indicate tunnels crossing borders of states or countries.</p> <p>Consistency of submitted data by agencies with shared border tunnel inspection, preservation, improvement or replacement responsibility is essential.</p>	
Examples			
Border Tunnel State or Count Code		Code	
Michigan Border Tunnel with Canada		CN	
New York Border Tunnel with New Jersey		34	

Border Tunnel Financial Responsibility			
Format N3			Item ID I.16
Specification		Commentary	
<p>Record the total percent financial responsibility for all entities within the State's geographical boundaries regardless of ownership.</p> <p>Leave item blank when the tunnel does not cross a border with another State or Country or when no owner within the state's geographical boundaries has any inspection, preservation, improvement or replacement responsibility.</p>		<p>The intent of this item is to capture the financial responsibility for all entities within the State's geographical boundaries, regardless of ownership of the tunnel (State, city, county, toll authorities, etc.) and to compare financial responsibility with neighboring states or countries.</p> <p>Financial responsibility includes current and future financial responsibilities for inspection, preservation, improvement or replacement whether by agency or contract forces. Agency financial responsibility may be documented in interagency agreements or memorandums of understanding and included as part of the tunnel file or record.</p>	
Examples			
<u>Border Tunnel Financial Responsibility</u>		<u>Code</u>	
55% Responsibility		55	
100% Responsibility		100	

<b><i>Border Tunnel Number</i></b>			
<u>Format</u> AN15			<u>Item ID</u> I.17
Specification		Commentary	
<p>Record the neighboring state's exact tunnel number as used in the Item ID I.1 - Tunnel Number item.</p> <p>Record this item for border tunnels when any owner within the state's geographical boundaries has shared responsibility for inspection, preservation, improvement or replacement.</p> <p>Leave item blank when the tunnel does not cross a border with another State or Country or when no owner within the state's geographical boundaries has any inspection, preservation, improvement or replacement responsibility. Also leave blank when the bordering country does not have a tunnel number.</p>			

Border Tunnel Inspection Responsibility											
Format N1			Item ID I.18								
Specification		Commentary									
<p>Record the border tunnel inspection responsibility for any entity within the State's geographical boundaries regardless of ownership using one of the following codes:</p> <table><tr><th>Code</th><th>Description</th></tr><tr><td>0</td><td>No responsibility</td></tr><tr><td>1</td><td>Shared responsibility with bordering State or country</td></tr><tr><td>2</td><td>Full responsibility</td></tr></table> <p>Leave item blank when the tunnel does not cross a border with another State or Country or when no owner within the state's geographical boundaries has any inspection, preservation, improvement or replacement responsibilities.</p>		Code	Description	0	No responsibility	1	Shared responsibility with bordering State or country	2	Full responsibility	<p>The intent of this item is to capture the border tunnel inspection responsibility for any entity within the State's geographical boundaries, regardless of ownership of the tunnel (State, city, county, toll authority etc.)</p> <p>Agency inspection responsibility may be documented in interagency agreements or memorandums of understanding and included as part of the tunnel file or record.</p>	
Code	Description										
0	No responsibility										
1	Shared responsibility with bordering State or country										
2	Full responsibility										

## 2.3—Age and Service Items

### Age and Service Items

The items in this section define when the tunnel was constructed, when it was reconstructed and the tunnel's level of service.

#### Item ID

- A.1 Year Built
- A.2 Year Rehabilitated
- A.3 Total Number of Lanes
- A.4 Average Daily Traffic
- A.5 Average Daily Truck Traffic
- A.6 Year of Average Daily Traffic
- A.7 Detour Length
- A.8 Service in Tunnel

Year Built			
<u>Format</u> N4			<u>Item ID</u> A.1
Specification		Commentary	
Record the year of construction of the structure. Code all 4 digits of the year in which construction of the structure was completed.  If the year built is unknown, provide a best estimate. See also Item ID A.2 - Year Rehabilitated.			
Examples			
<u>Year Built</u>		<u>Code</u>	
1956		1956	
2012		2012	

Year Rehabilitated			
Format N4			Item ID A.2
Specification		Commentary	
<p>Record the year of most recent rehabilitation of the structure. Code all 4 digits of the latest year in which rehabilitation of the structure was completed. If there has been no rehabilitation code 0000.</p> <p>For a tunnel to be defined as rehabilitated, the type of work performed, whether or not it meets current minimum standards, must have been eligible for funding under any of the Federal-aid funding categories.</p> <p>The eligibility criteria would apply to the work performed regardless of funding source.</p>		<p>Some types of eligible work not to be considered as rehabilitation are:</p> <ul style="list-style-type: none"><li>- Safety feature replacement or upgrading (for example, tunnel rail, approach guardrail or impact attenuators).</li><li>- Painting of structural steel.</li><li>- Overlay of tunnel deck as part of a larger highway surfacing project (for example, overlay carried across tunnel invert for surface uniformity without additional tunnel work).</li><li>- Utility work.</li><li>- Emergency repair to restore structural integrity to the previous condition following an accident.</li><li>- Retrofitting to correct a deficiency which does not substantially alter physical geometry or increase the load carrying capacity.</li><li>- Work performed to keep a tunnel operational while plans for complete rehabilitation are under preparation (for example, adding a temporary support).</li></ul>	
Examples			
Year Rehabilitated		Code	
1985		1985	
Never rehabilitated		0000	

Total Number of Lanes			
Format N2			Item ID A.3
Specification		Commentary	
Record the number of lanes being carried through the tunnel as a 2-digit number.		Include all lanes carrying highway traffic (i.e., cars, trucks, buses) which are striped or otherwise operated as a full width traffic lane for the entire length of the tunnel. This shall include any full width merge lanes and ramp lanes, and shall be independent of directionality of usage.	
Examples			
Total Number of Lanes		Code	
Two lanes inbound, two lands outbound		04	
One land inbound, two lanes outbound		03	

Average Daily Traffic			
<u>Format</u> N6			<u>Item ID</u> A.4
Specification		Commentary	
Record a 6-digit number that shows the most recent average daily traffic (ADT) count available for the inventory route identified in Item ID I.7 - Route Number. If the tunnel is closed, code the actual ADT from before the closure occurred.		Included in this item are the trucks referred to in Item ID A.5 – Average Daily Truck Traffic.	
Examples			
<u>Average Daily Traffic</u>		<u>Code</u>	
15,600		015600	
24,000		024000	

Average Daily Truck Traffic			
Format N2			Item ID A.5
Specification		Commentary	
Record a 2-digit percentage that shows the percentage of Item ID A.4 – Average Daily Traffic that is truck traffic. Do not include vans, pickup trucks and other light delivery trucks in this percentage.		If this information is not available, an estimate which represents the average percentage for the category of road carried by the tunnel may be used.  May be left blank if Item ID A.4 - Average Daily Traffic is not greater than 100.	
Examples			
<u>Average Daily Truck Traffic</u>		<u>Code</u>	
7% trucks		07	
12% trucks		12	

Year of Average Daily Traffic			
Format N4			Item ID A.6
Specification		Commentary	
Record all four digits of the year represented by the ADT in Item ID A.4 – Average Daily Traffic.			
Examples			
<u>Year of Average Daily Traffic</u>		<u>Code</u>	
1999		1999	

Detour Length			
Format N3			Item ID A.7
Specification		Commentary	
Record the actual length to the nearest mile of the detour length. The detour length should represent the total additional travel for a vehicle which would result from closing of the tunnel.		If multiple bores exist, and following an accident, one of the bores can be used to detour traffic code as 001. If an accident would result in the closure of all bores for an extended period of time, then code the detour length for the additional travel length.  The factor to consider when determining if a bypass is available at the site is the potential for moving vehicles, including military vehicles, around the tunnel.	
Examples			
<u>Detour Length</u>		<u>Code</u>	
121 miles		121	
Multiple bore tunnel		001	



**Example of Multiple Bore Tunnel**

Service in Tunnel			
Format N1			Item ID A.8
Specification		Commentary	
<p>Record the type of service in the tunnel using a 1-digit code.</p> <p>The types of service in the tunnel and shall be coded using one of the following codes:</p> <p>1 = Highway</p> <p>2 = Highway and Railroad</p> <p>3 = Highway and Pedestrian</p> <p>4 = Highway, Railroad and Pedestrian</p> <p>5 = Other</p>		<p>Bicycle lanes or paths should be coded as pedestrian.</p>	
Examples			
Service in Tunnel		Code	
Highway		1	
Highway/railroad		2	

## 2.4—Classification Items

### Classification Items

The items in this section define the owner, operator and highway classification of the tunnel.

#### Item ID

- C.1 Owner
- C.2 Operator
- C.3 Direction of Traffic
- C.4 Toll
- C.5 NHS Designation
- C.6 STRAHNET Designation
- C.7 Functional Classification

<b>Owner</b>			
<u>Format</u> N2			<u>Item ID</u> C.1
Specification		Commentary	
Record the owner of the tunnel using the codes below to represent the type of agency that is the primary owner of the structure.		If more than one agency has equal ownership, code one agency in the hierarchy of State, Federal, county, city, railroad, other, and private.	
<u>Code</u>	<u>Description</u>		
01	State Highway Agency		
02	County Highway Agency		
03	Town or Township Highway Agency		
04	City or Municipal Highway Agency		
11	State Park, Forest, or Reservation Agency		
12	Local Park, Forest, or Reservation Agency		
21	Other State Agencies		
25	Other Local Agencies		
26	Private (other than railroad)		
27	Railroad		
31	State Toll Authority		
32	Local Toll Authority		
60	Other Federal Agencies (not listed below)		
61	Indian Tribal Government		
62	Bureau of Indian Affairs		
63	Bureau of Fish and Wildlife		
64	U.S. Forest Service		
66	National Park Service		
67	Tennessee Valley Authority		
68	Bureau of Land Management		
69	Bureau of Reclamation		
70	Corps of Engineers (Civil)		
71	Corps of Engineers (Military)		
72	Air Force		
73	Navy/Marines		
74	Army		
75	NASA		
76	Metropolitan Washington Airports Service		
80	Unknown		

Examples	
<u>Owner</u>	<u>Code</u>
CALTRANS	01
PennDOT and City of Pittsburgh each own 50%	01

DRAFT

<b>Operator</b>			
<u>Format</u> N2			<u>Item ID</u> C.2
Specification		Commentary	
Record the agency responsible for the maintenance of the tunnel using the codes from Item ID C.1- Owner to represent the type of agency that has primary responsibility for maintaining the structure.		If more than one agency has equal maintenance responsibility, code one agency in the hierarchy of State, Federal, county, city, railroad, other, and private.	

Direction of Traffic															
Format N1			Item ID C.3												
Specification		Commentary													
<p>Record the direction of traffic of the inventory route identified in Item ID I.7 – Route Number as a 1-digit number using one of the codes below.</p> <p>The first and second digits indicate the types of service in the tunnel and shall be coded using one of the following codes:</p> <table><tr><th>Code</th><th>Description</th></tr><tr><td>0</td><td>Highway traffic not carried</td></tr><tr><td>1</td><td>1-way traffic</td></tr><tr><td>2</td><td>2-way traffic</td></tr><tr><td>3</td><td>Variable traffic</td></tr><tr><td>4</td><td>One lane 2-way traffic</td></tr></table>		Code	Description	0	Highway traffic not carried	1	1-way traffic	2	2-way traffic	3	Variable traffic	4	One lane 2-way traffic	<p>Code 3, Variable traffic is intended to cover those tunnels in which the direction of traffic can be changed.</p> <p>One lane 2-way traffic occurs when 2 lanes approach a narrow unstriped tunnel requiring vehicles to alternate turns through the tunnel.</p> <p>When coding a tunnel with multiple bores, if traffic moves in both directions regardless of the individual traffic direction of a single bore, code as 2-way traffic.</p>	
Code	Description														
0	Highway traffic not carried														
1	1-way traffic														
2	2-way traffic														
3	Variable traffic														
4	One lane 2-way traffic														

<b><i>Toll</i></b>			
<u>Format</u> N1			<u>Item ID</u> C.4
Specification		Commentary	
Record whether the inventory route has no tolls, has a toll at the tunnel or is on a toll route for the inventory route identified in Item ID I.7 – Route Number.			
Use one of the following codes:			
<u>Code</u>	<u>Description</u>		
0	No tolls.		
1	Toll at tunnel.		
2	Located on toll route.		

<b><i>NHS Designation</i></b>			
<u>Format</u> N1			<u>Item ID</u> C.5
Specification		Commentary	
Record whether the inventory route is on the National Highway System (NHS) or not on that system for the inventory route identified in Item ID I.7 – Route Number.			
Use one of the following codes:			
<u>Code</u>	<u>Description</u>		
0	Inventory Route is not on the NHS.		
1	Inventory Route is on the NHS.		

STRAHNET Designation									
Format N1			Item ID C.6						
Specification		Commentary							
<p>Record whether the inventory route is on the STRAHNET or not on that system for the inventory route identified in Item ID I.7 – Route Number. For the purposes of this item, the STRAHNET Connectors are considered included in the term STRAHNET. Indicate STRAHNET highway conditions using one of the following codes:</p> <p>Use one of the following codes:</p> <table><tr><th>Code</th><th>Description</th></tr><tr><td>0</td><td>Inventory Route is not a STRAHNET route.</td></tr><tr><td>1</td><td>Inventory Route is a STRAHNET route.</td></tr></table>		Code	Description	0	Inventory Route is not a STRAHNET route.	1	Inventory Route is a STRAHNET route.		
Code	Description								
0	Inventory Route is not a STRAHNET route.								
1	Inventory Route is a STRAHNET route.								

Functional Classification			
Format N2			Item ID C.7
Specification		Commentary	
<p>Record the functional classification for the inventory route identified in Item ID I.7 – Inventory Route using a two-digit number comprised of a first digit (Urban or Rural) and a second digit (System Classification) of the following codes:</p> <p>Two part code for Functional Classification –</p> <p>Urban or Rural (first digit)</p> <p>1 = Urban</p> <p>2 = Rural</p> <p>System Classification (second digit)</p> <p>1 = Interstate</p> <p>2 = Principal Arterial – Other Freeways or Expressways</p> <p>3 = Principal Arterial – Other</p> <p>4 = Minor Arterial</p> <p>5 = Major Collector</p> <p>6 = Minor Collector</p> <p>7 = Local</p>			
Examples			
Functional Classification		Code	
Rural minor collector		26	
Urban Interstate		11	

## 2.5—Geometric Data Items

### Geometric Data Items

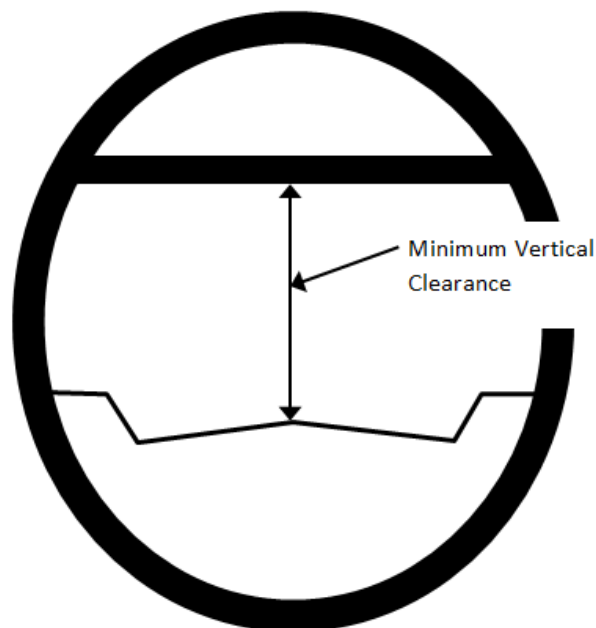
The items in this section define the geometric data of the tunnel.

#### Item ID

- G.1 Tunnel Length
- G.2 Minimum Vertical Clearance over Tunnel Roadway
- G.3 Roadway Width, Curb-to-Curb
- G.4 Left Curb and Right Curb Widths

Tunnel Length			
Format N6			Item ID G.1
Specification		Commentary	
Record a 6-digit number to represent the length of the tunnel to the nearest foot. The length shall be measured along the center line of roadway between the faces of the portals.		When a tunnel is broken into longitudinal sections, the length should be for the section of the tunnel being recorded.  Multiple bores recorded as a single tunnel only have the length of one bore coded, i.e. a west bound bore and an east bound bore would only have one length coded.	
Examples			
Tunnel Length		Code	
860.4 feet		000860	
2,400 feet		002400	

Minimum Vertical Clearance over Tunnel Roadway			
Format FP(5,1)			Item ID G.2
Specification		Commentary	
Record the minimum vertical clearance between the mainline tunnel roadway surface and any overhead restriction within the tunnel.		<p>The roadway surface includes any surface on which a vehicle can travel, including shoulders.</p> <p>Ramps should be excluded when included as part of a tunnel system. The intent is to determine the restrictions of the primary route of the tunnel.</p> <p>Vertical clearance, as shown in figure 2.6.1 below, represents the Minimum Vertical Clearance over Tunnel Roadway.</p>	
Examples			
<u>Minimum Vertical Clearance Over Tunnel Roadway</u>		<u>Code</u>	
16.54 feet		16.5	
20.00 feet		20.0	



**Figure 2.6.1 - Drawing of Minimum Vertical Clearance**

Roadway Width, Curb-to-Curb			
Format FP(4,1)			Item ID G.3
Specification		Commentary	
Record the most restrictive minimum distance between curbs or rails on the mainline tunnel roadway.		Ramps should be excluded when included as part of a tunnel system. The intent is to determine the restrictions of the primary route of the tunnel.	
Examples			
Roadway Width, Curb-to-Curb		Code	
24.00 feet		24.0	
30.43 feet		30.4	

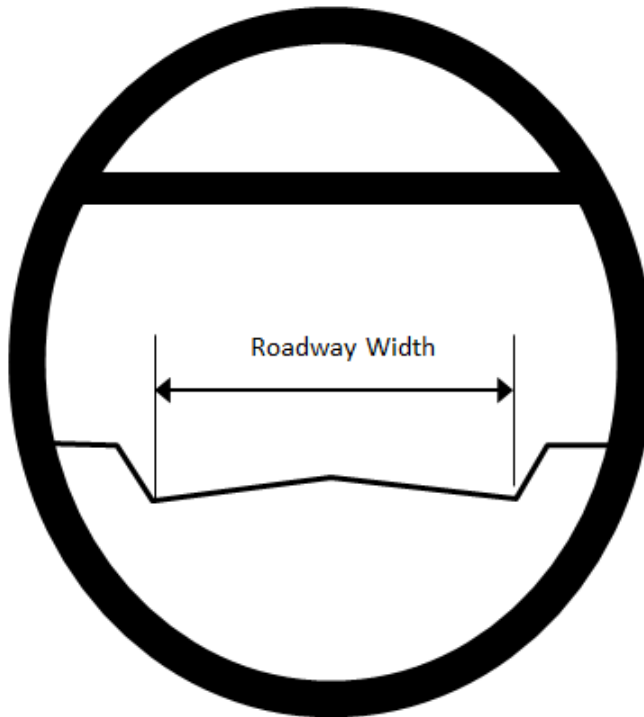
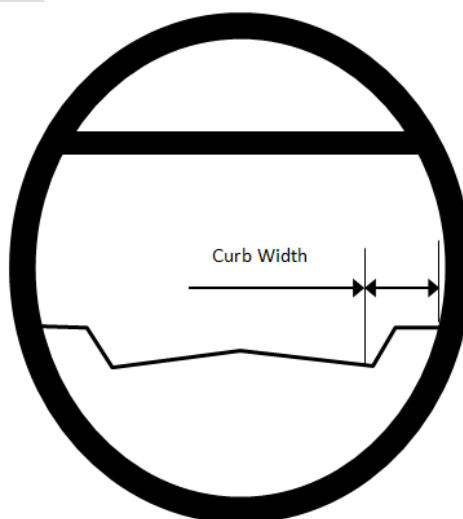


Figure 2.6.2 - Drawing of Roadway Width

Left Curb and Right Curb Widths									
Format N6			Item ID G.4						
Specification		Commentary							
<p>Record two contiguous 3-digit numbers to represent the widths of the left and right curbs or sidewalks to nearest tenth of a foot (with assumed decimal points). This is a 6-digit number composed of 2 segments, with the leftmost 3 digits representing the left curb or sidewalk and the rightmost 3 digits representing the right curb or sidewalk. "Left" and "Right" should be determined on the basis of direction of the inventory route.</p> <table><tr><th>Description</th><th>Length</th></tr><tr><td>Left curb/sidewalk width</td><td>3 digits</td></tr><tr><td>Right curb/sidewalk width</td><td>3 digits</td></tr></table>		Description	Length	Left curb/sidewalk width	3 digits	Right curb/sidewalk width	3 digits		
Description	Length								
Left curb/sidewalk width	3 digits								
Right curb/sidewalk width	3 digits								
Examples									
Curb or Sidewalk		Code							
Left : none	Right: 6.9 feet	000069							
Left : 5.0 feet	Right: 5.0 feet	050050							
Left : none	Right: none	000000							
Left : 1.8 feet	Right: 3.6 feet	018036							



**Figure 2.6.3 - Drawing of Curb Width**

## 2.6—Inspection Items

### Inspection Items

The items in this section describe when inspections were performed and the type of inspections performed.

#### Item ID

- D.1 Routine Inspection Target Date
- D.2 Actual Routine Inspection Date
- D.3 Routine Inspection Interval
- D.4 In-Depth Inspection
- D.5 Damage Inspection
- D.6 Special Inspection

<i><b>Routine Inspection Target Date</b></i>			
<u>Format</u> N4			<u>Item ID</u> D.1
Specification		Commentary	
Record the routine inspection target date as a month and day. Code a 4-digit number to represent the month and day. The number of the month should be coded in the first 2 digits with a leading zero as required and the year coded as the third and fourth digits with a leading zero as required.		This date should only be modified by the Program Manager in rare circumstances.	
Examples			
<u>Routine Inspection Target Date</u>		<u>Code</u>	
November 1999		1199	
August 2012		0812	

Actual Routine Inspection Date			
Format N4			Item ID D.2
Specification		Commentary	
Record the month and year that the actual routine inspection of the tunnel was performed. Code a 4-digit number to represent the month and year. The number of the month should be coded in the first 2 digits with a leading zero as required and the last 2 digits of the year coded as the third and fourth digits of the field.		This date should indicate when the routine inspection began.	
Examples			
Actual Routine Inspection Date		Code	
November 1999		1199	
August 2012		0812	

<i><b>Routine Inspection Interval</b></i>			
<u>Format</u> N2			<u>Item ID</u> D.3
Specification		Commentary	
Record two digits to represent the number of months between designated routine inspections. A leading zero shall be coded as required.		The designated inspection interval could vary from inspection to inspection depending on the condition of the tunnel at the time of inspection and the procedures established by the individual in-charge of the inspection program.	
<b>Examples</b>			
<u>Routine Inspection Interval</u>		<u>Code</u>	
Every 6 months		06	
Every 24 months		24	

In-Depth Inspection			
Format N1			Item ID D.4
Specification		Commentary	
Record this item for all records in the inventory. For the tunnel identified in Item ID I.1 – Tunnel Number, record whether the tunnel has an In-Depth Inspection scheduled.		A close-up inspection of one, several, or all tunnel structural elements or functional systems to identify any deficiencies not readily detectable using routine inspection procedures; hands-on inspection may be necessary at some locations. In-depth inspections may occur more or less frequently than routine inspections, as outlined in the tunnel-specific inspection procedures.	
Use one of the following codes:			
<u>Code</u>	<u>Description</u>		
0	In-Depth Inspection has not been scheduled.		
1	In-Depth Inspection has been scheduled.		

Damage Inspection									
Format N1			Item ID D.5						
Specification		Commentary							
<p>Record this item for all records in the inventory. For the tunnel identified in Item ID I.1 – Tunnel Number, record whether the tunnel has a Damage Inspection performed. This should be coded as 1 if a damage inspection has been performed since the previous routine inspection (Item ID D.2 – Actual Routine Inspection Date).</p> <p>Use one of the following codes:</p> <table><tr><th>Code</th><th>Description</th></tr><tr><td>0</td><td>Damage Inspection has not been performed.</td></tr><tr><td>1</td><td>Damage Inspection has been performed.</td></tr></table>		Code	Description	0	Damage Inspection has not been performed.	1	Damage Inspection has been performed.	<p>This is an unscheduled inspection to assess structural damage resulting from environmental factors or human actions.</p>	
Code	Description								
0	Damage Inspection has not been performed.								
1	Damage Inspection has been performed.								

Special Inspection									
Format N1			Item ID D.6						
Specification		Commentary							
Record this item for all records in the inventory. For the tunnel identified in Item ID I.1 – Tunnel Number, record whether the tunnel has a Special Inspection scheduled.  Use one of the following codes:  <table><tr><th>Code</th><th>Description</th></tr><tr><td>0</td><td>Special Inspection has not been scheduled.</td></tr><tr><td>1</td><td>Special Inspection has been scheduled.</td></tr></table>		Code	Description	0	Special Inspection has not been scheduled.	1	Special Inspection has been scheduled.	An inspection, scheduled at the discretion of the tunnel owner, used to monitor a particular known or suspected deficiency.	
Code	Description								
0	Special Inspection has not been scheduled.								
1	Special Inspection has been scheduled.								

## 2.7—Load Rating and Posting Items

### Load Rating and Posting Items

The items in this section are related to load rating and posting of the highway tunnel.

#### Item ID

- L.1 Load Rating Method
- L.2 Rating Factor for AASHTO Type 3 Truck
- L.3 Rating for AASHTO Type 3 Truck
- L.4 Rating Factor for AASHTO Type 3S2 Truck
- L.5 Rating for AASHTO Type 3S2 Truck
- L.6 Rating Factor for AASHTO Type 3-3 Truck
- L.7 Rating for AASHTO Type 3-3 Truck
- L.8 Rating Factor for State Routine Permit Truck
- L.9 Rating for State Routine Permit Truck
- L.10 Tunnel Open, Posted or Closed to Traffic
- L.11 Field Load Posting
- L.12 Traffic Restrictions

Load Rating Method			
Format AN1			Item ID L.1
Specification		Commentary	
Record the method used to determine the Load Rating coded in Item ID L.2 – Rating Factor for AASHTO Type 3 Truck through Item ID L.9 – Rating for State Routine Permit Truck.  Use one of the following codes:		This is intended to capture the method used to determine the load capacity of the road surface.	
<u>Code</u>	<u>Description</u>		
0	Field evaluation and documented engineering judgment		
1	Load Factor (LF)		
2	Allowable Stress (AS)		
3	Load and Resistance Factor (LRFR)		
4	Load Testing		
5	No rating analysis or evaluation performed		
6	Load Factor (LF) rating reported by rating factor (RF) method using MS18 loading		
7	Allowable Stress (AS) rating reported by rating factor (RF) method using MS18 loading		
8	Load and Resistance Factor Rating (LRFR) rating reported by rating factor (RF) method using HL-93 loadings		
A	Assigned rating based on Load Factor Design (LFD)		
B	Assigned ratings based on Allowable Stress Design (ASD)		
C	Assigned ratings based on Load Factor Design (LFD) reported by rating factor (RF) using MS18 loading		
D	Assigned rating based on Load Factor Design (LFD) reported by rating factor (RF) using MS18 loading		

Specification Cont.		Commentary Cont.
E	Assigned ratings based on Allowable Stress Design (ASD) reported by rating factor (RF) using MS18 loadings	This is intended to capture the method used to determine the load capacity of the road surface.
F	Assigned ratings based on Load and Resistance Factor Design (LRFD) reported by rating factor (RF) using HL93 loadings	
N	Load rating is not required.	

<b>Rating Factor for AASHTO Type 3 Truck</b>			
<u>Format</u> FP(4,2)			<u>Item ID</u> L.2
Specification		Commentary	
Record the load rating factor truncated to the hundredth using the standard AASHTO Type 3 truck as defined within the Manual for Bridge Evaluation.		This is the factor used to determine the posting recommendations for the tunnel for the AASHTO Type 3 Truck. The rating factor is to be recorded for this item, regardless if it results in a rating value less than 3 tons.	
For roadway surface on grade, leave this item blank.		The actual maximum load capacity for the shored structure should be used to determine this item.	

<b>Rating for AASHTO Type 3 Truck</b>			
<u>Format</u> FP(4,1)			<u>Item ID</u> L.3
Specification		Commentary	
Record the operating load rating truncated to the tenth using the standard AASHTO Type 3 truck as defined within the Manual for Bridge Evaluation.			
For roadway surface on grade, leave this item blank.			

Examples for Item ID L.2 – Rating Factor for AASHTO Type 3 Truck and Item L.3 – Rating for AASHTO Type 3 Truck	
<u>Rating Factor for AASHTO Type 3 Truck</u>	<u>Code</u>
2.05	2.05
<u>Rating for AASHTO Type 3 Truck</u>	<u>Code</u>
2.05*25 tons = 51.25	51.3

<b>Rating Factor for AASHTO Type 3S2 Truck</b>			
<u>Format</u> FP(4,2)			<u>Item ID</u> L.4
Specification		Commentary	
Record the operating load rating factor truncated to the hundredth using the standard AASHTO Type 3S2 truck as defined within the Manual for Bridge Evaluation.		This is the factor used to determine the posting recommendations for the tunnel for the AASHTO Type 3S2 Truck. The rating factor is to be recorded for this item, regardless if it results in a rating value less than 3 tons.	
For roadway surface on grade, leave this item blank.		The actual maximum load capacity for the shored structure should be used to determine this item.	

<b>Rating for AASHTO Type 3S2 Truck</b>			
<u>Format</u> FP(4,1)			<u>Item ID</u> L.5
Specification		Commentary	
Record the operating load rating truncated to the tenth using the standard AASHTO Type 3S2 truck as defined within the Manual for Bridge Evaluation.			
For roadway surface on grade, leave this item blank.			

<b>Rating Factor for AASHTO Type 3-3 Truck</b>			
<u>Format</u> FP(4,2)			<u>Item ID</u> L.6
Specification		Commentary	
Record the operating load rating factor truncated to the hundredth using the standard AASHTO Type 3-3 truck as defined within the Manual for Bridge Evaluation.		This is the factor used to determine the posting recommendations for the tunnel for the AASHTO Type 3-3 Truck. The rating factor is to be recorded for this item, regardless if it results in a rating value less than 3 tons.	
For roadway surface on grade, leave this item blank.		The actual maximum load capacity for the shored structure should be used to determine this item.	

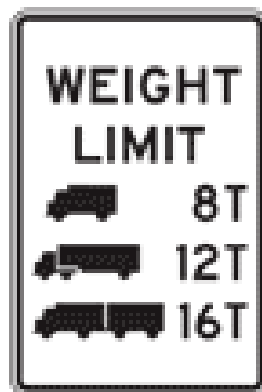
<b>Rating for AASHTO Type 3-3 Truck</b>			
<u>Format</u> FP(4,1)			<u>Item ID</u> L.7
Specification		Commentary	
Record the operating load rating truncated to the tenth using the standard AASHTO Type 3-3 truck as defined within the Manual for Bridge Evaluation.			
For roadway surface on grade, leave this item blank.			

<b>Rating Factor for State Routine Permit Truck</b>			
<u>Format</u> FP(4,2)			<u>Item ID</u> L.8
Specification		Commentary	
<p>Record the load rating factor truncated to the hundredth using the state routine permit truck that controls when performing a load rating.</p> <p>For roadway surface on grade, leave this item blank.</p>		<p>The rating factor is to be recorded for this item regardless if it results in a load rating less than 3 tons.</p> <p>A routine permit truck is a vehicle that receives a valid permit for unlimited trips over a period of time, not to exceed one year. The permit vehicles are of a given configuration and are within specified gross weight and axle weight limits. These vehicles are free to mix within the traffic stream and move at normal speeds without any movement restrictions.</p>	

<b>Rating for State Routine Permit Truck</b>			
<u>Format</u> FP(4,1)			<u>Item ID</u> L.9
Specification		Commentary	
<p>Record the load rating truncated to the tenth using the State routine permit truck that controls when performing a load rating.</p> <p>For roadway surface on grade, leave this item blank.</p>		<p>A routine permit truck is a vehicle that receives a valid permit for unlimited trips over a period of time, not to exceed one year. The permit vehicles are of a given configuration and are within specified gross weight and axle weight limits. These vehicles are free to mix within the traffic stream and move at normal speeds without any movement restrictions.</p>	

Tunnel Open, Posted, or Closed to Traffic			
Format AN1			Item ID L.10
Specification		Commentary	
Record information the operational status of a tunnel.		The field inspection could show that a tunnel is posted, but Item ID L.11 – Field Load Posting may indicate that posting is not required. This is possible and acceptable coding since Item ID L.11 – Field Load Posting is based on the operating load level and the governing agency's posting procedures may specify posting at some stress level other than the operating rating.	
One of the following codes shall be used:			
<u>Code</u>	<u>Description</u>		
A	Open, no restriction		
B	Open, posting recommended but not legally implemented (all signs not in place or not correctly implemented)		
D	Open, would be posted or closed except for temporary shoring, etc. to allow for unrestricted traffic		
E	Open, temporary structure in place to carry legal loads while tunnel is closed and awaiting replacement or rehabilitation		
G	New tunnel not yet open to traffic		
K	Tunnel closed to all traffic		
P	Posted for load (may include other restrictions such as temporary structures which are load posted)		
R	Posted for other load-capacity restriction (speed, number of vehicles in tunnel, etc.)		

Field Load Posting															
Format N10			Item ID L.11												
Specification		Commentary													
<p>Record this item if Item L.12 - Tunnel Open, Posted or Closed to Traffic is coded "P". Record up to five loads that are on the load posting signs.</p> <p>Use the following codes:</p> <table><tr><th>Code (Load)</th><th>Description</th></tr><tr><td>XX</td><td>Total Tonnage</td></tr><tr><td>XX</td><td>Axle Tonnage</td></tr><tr><td>XX</td><td>Type 3 Truck</td></tr><tr><td>XX</td><td>Type 3S2 Truck Posting</td></tr><tr><td>XX</td><td>Type 3-3 Truck Posting</td></tr></table> <p>The format is right justified. Use "0" to fill in the left unused space.</p>		Code (Load)	Description	XX	Total Tonnage	XX	Axle Tonnage	XX	Type 3 Truck	XX	Type 3S2 Truck Posting	XX	Type 3-3 Truck Posting	<p>The intent of this item is to capture the loads that should be listed on the load posting signs for the tunnel in US Customary tons.</p> <p>If only gross load is used, the other loads can be left blank.</p> <p>If the loads on the signs are higher than the loads listed complete Item L.12 - Tunnel Open, Posted or Closed to Traffic and notify the tunnel owner to change the signs.</p>	
Code (Load)	Description														
XX	Total Tonnage														
XX	Axle Tonnage														
XX	Type 3 Truck														
XX	Type 3S2 Truck Posting														
XX	Type 3-3 Truck Posting														
Examples															
<u>Field Load Posting</u>		<u>Code</u>													
Based on the figure 2.7.1		0000081216													



R12-5

Figure 2.7.1 – MUTCD Weight Limit Sign R12-5

Traffic Restrictions			
<u>Format</u> N3			<u>Item ID</u> L.12
Specification		Commentary	
<p>Record the three digit number to define the traffic restrictions for the tunnel. This item provides additional information about the actual operational status of a structure. Specifically, traffic restrictions will be coded as follows:</p> <p>A three digit code shall be used as follows:</p> <p>First Digit- Height Restricted</p> <p>Second Digit – Hazardous Material Restricted</p> <p>Third Digit – Other Restricted</p> <p><u>Code</u>   <u>Description</u></p> <p>1        Yes</p> <p>0        No</p>			
Examples			
<u>Traffic Restrictions</u>		<u>Code</u>	
Height restricted, no other restrictions		100	

## 2.8—Navigation Items

### Navigation Items

The items in this section are related to navigable waterways over the tunnel.

#### Item ID

- N.1 Under Navigable Waterway
- N.2 Navigable Waterway Clearance
- N.3 Tunnel or Portal Island Protection from Navigation

Under Navigable Waterway									
Format N1			Item ID N.1						
Specification		Commentary							
<p>Record the one digit number to describe if the waterway above the tunnel is navigable. Some tunnels are located under navigable waterways. If there is a navigable waterway above the tunnel, this item shall be coded 1. If there is not a navigable waterway above the tunnel, this item shall be coded 0.</p> <p>Use one of the following codes:</p> <table><tr><th>Code</th><th>Description</th></tr><tr><td>0</td><td>A navigable waterway is not above the tunnel.</td></tr><tr><td>1</td><td>A navigable waterway is above the tunnel.</td></tr></table>		Code	Description	0	A navigable waterway is not above the tunnel.	1	A navigable waterway is above the tunnel.		
Code	Description								
0	A navigable waterway is not above the tunnel.								
1	A navigable waterway is above the tunnel.								

Navigable Waterway Clearance			
Format FP(3,1)			Item ID N.2
Specification		Commentary	
<p>Record the minimum vertical clearance imposed at the site as measured above a datum that is specified on a navigation permit issued by a control agency (between top of tunnel or tunnel protection system and average water level). This measurement will show the clearance that is allowable for navigational purposes.</p> <p>If the tunnel is not under a navigable waterway, code as 00.0.</p>			
Examples			
Navigable Waterway Clearance		Code	
50.00 feet		50.0	
60.63 feet		60.6	
No waterway over tunnel		00.0	

<b><i>Tunnel or Portal Island Protection from Navigation</i></b>															
<u>Format</u> N1			<u>Item ID</u> N.3												
Specification		Commentary													
<p>Record the codes below to indicate the presence and adequacy of top of tunnel protection and portal islands to protect against vessel collision.</p> <p>Use one of the following codes:</p> <table border="1"> <thead> <tr> <th><u>Code</u></th> <th><u>Description</u></th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Navigation protection not required or not under navigable waterway</td> </tr> <tr> <td>1</td> <td>In place and functioning</td> </tr> <tr> <td>2</td> <td>In place but in a deteriorated condition</td> </tr> <tr> <td>3</td> <td>In place but reevaluation of design suggested</td> </tr> <tr> <td>4</td> <td>None present but reevaluation suggested</td> </tr> </tbody> </table>		<u>Code</u>	<u>Description</u>	0	Navigation protection not required or not under navigable waterway	1	In place and functioning	2	In place but in a deteriorated condition	3	In place but reevaluation of design suggested	4	None present but reevaluation suggested		
<u>Code</u>	<u>Description</u>														
0	Navigation protection not required or not under navigable waterway														
1	In place and functioning														
2	In place but in a deteriorated condition														
3	In place but reevaluation of design suggested														
4	None present but reevaluation suggested														

## 2.9—Structure Type and Material Items

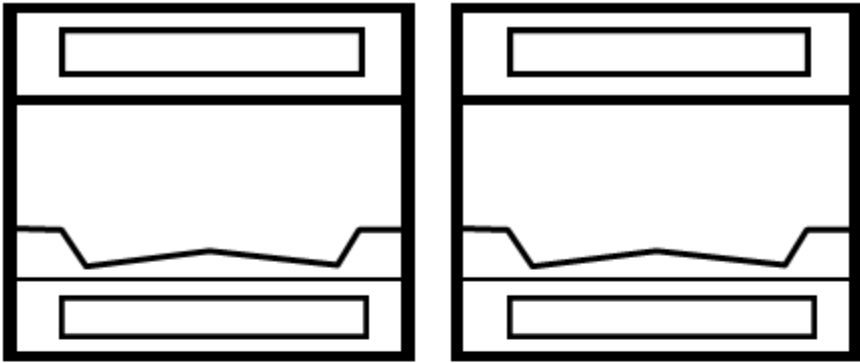
### Structure Type and Material Items

The items in this section are related to the tunnel shape and the adjacent materials surrounding the tunnel.

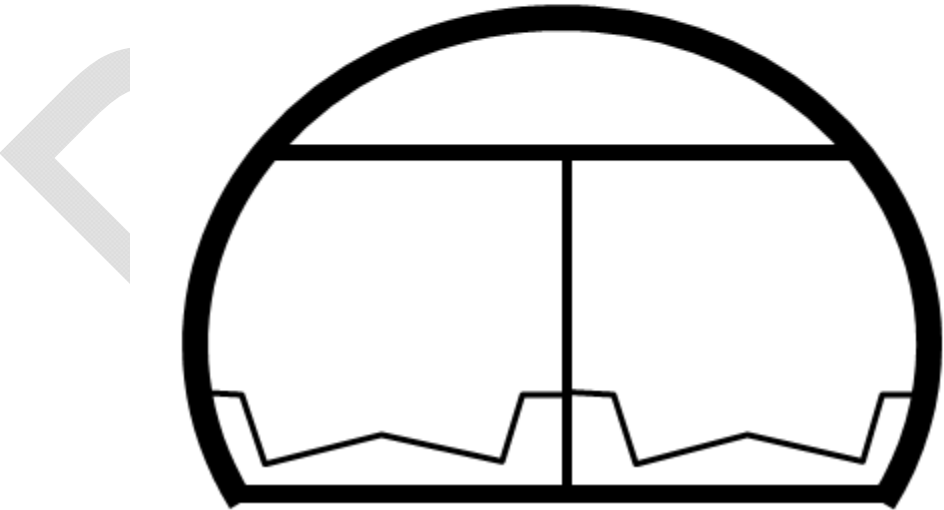
#### Item ID

- S.1 Number of Bores
- S.2 Tunnel Shape
- S.3 Portal Shapes
- S.4 Ground Conditions
- S.5 Complex

<i>Number of Bores</i>			
<u>Format</u> N1			<u>Item ID</u> S.1
Specification		Commentary	
Record the one digit number defining the number of bores in a tunnel. When recording and coding for this item, use the number of bores associated with Item ID I.1 – Tunnel Number.		<p>Definition of a Tunnel Bore - an underground passageway for vehicles that pass under a mountain, waterway, or an urban area.</p> <p>A ramp should not be counted as a bore unless it is being coded as a separate tunnel.</p>	



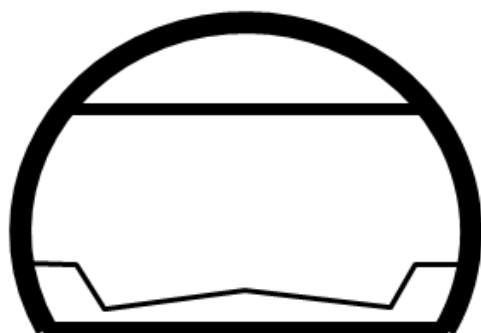
Two Bores



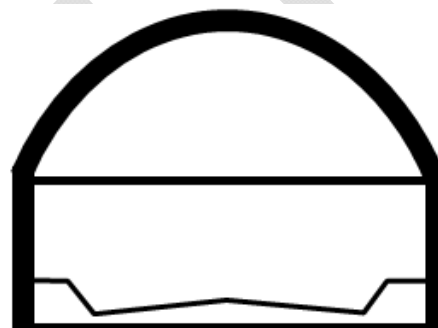
One Bore

Figure 2.9.1 – Number of Bores

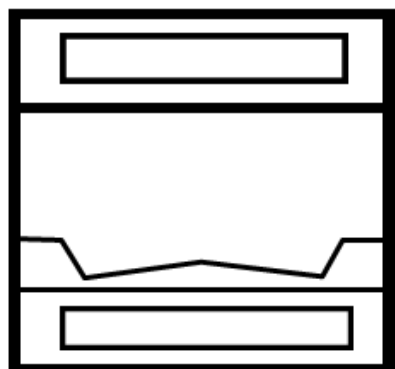
<b><i>Tunnel Shape</i></b>			
<u>Format</u> N1			<u>Item ID</u> S.2
Specification		Commentary	
Record the type of tunnel shape.		See figure 2.9.2 below.	
Use one of the following codes:			
<u>Code</u>	<u>Description</u>		
1	Oval		
2	Horseshoe		
3	Box		
4	Circular		



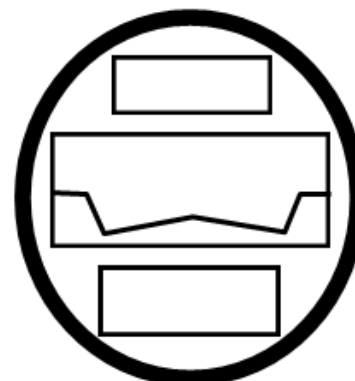
Oval Tunnel



Horseshoe Tunnel



Single Box Tunnel



Circular Tunnel

**Figure 2.9.2 – Tunnel Shapes**

<b>Portal Shape</b>			
<u>Format</u> N1			<u>Item ID</u> S.3
Specification		Commentary	
Record the type of portal shape.  Use one of the following codes:		See example shapes shown for Item ID S.2 - Tunnel Shape, figure 2.9.2.	
<u>Code</u>	<u>Description</u>		
1	Oval		
2	Horseshoe		
3	Box		
4	Circular		
5	Other		

<b>Ground Conditions</b>			
<u>Format</u> N1			<u>Item ID</u> S.4
Specification		Commentary	
Record the type of ground conditions.  Use one of the following codes:		<u>Definitions:</u> Soil is used to define ground conditions consisting primarily of clay, silt, sand, gravel or a mixture.	
<u>Code</u>	<u>Description</u>		
1	Soil		
2	Rock	Rock is used to define ground conditions consisting primarily of material that has rock structure in weathered to sound condition.	
3	Mixed Face	The term mixed face usually refers to a situation where the lower part of the working face is in rock while the upper part is in soil or the revers.	

Complex			
Format N1			Item ID S.5
Specification		Commentary	
Record the one digit number to define if a tunnel is complex. If the tunnel is complex, this item shall be coded 1. If the tunnel is not complex, this item shall be coded 0.  Use one of the following codes:		A complex tunnel typically includes mechanical or fire suppression equipment to ventilate exhaust from the tunnel or provide protection against tunnel fires. A non-complex tunnel in contrast is typically of a shorter length, not requiring any ventilation, and may or may not have lighting installed.	
<u>Code</u>	<u>Description</u>		
0	The tunnel is not complex.		
1	The tunnel is complex.		

## **Section 3—Elements**

**Section 3.1—Introduction**

**Section 3.2—Structural Section**

**Section 3.3—Civil Section**

**Section 3.4—Mechanical Systems Section**

**Section 3.5—Electrical Systems Section**

**Section 3.6—Lighting Systems Section**

**Section 3.7—Fire/Life Safety/Security Systems Section**

**Section 3.8—Signs Section**

**Section 3.9—Protective Systems Section**

### 3.1—Introduction

This section is comprised of tunnel elements arranged by general element type, material, and in accordance to their physical location in the tunnel to facilitate ease of use by tunnel inspectors in the field.

Element Name	
<u>Unit of Measure</u> XXXXX	<u>Element Number</u> XXXX
<u>Specification</u>	<u>Commentary</u>
<p>Description of the element and how to measure the element</p> <p>Record the element number, total element quantity and element quantity assigned to each condition state. If this element does not exist for a tunnel, then do not code this element. For element condition states, refer to the table below.</p>	Additional information about the element to supplement the specification portion

Condition State Definitions				
Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
General Condition	Good condition – no notable distress	Fair condition- isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	Severe condition - The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.

The format of an element is described in the two tables. The first table details what an element is in 5 parts: (1) Element Name, (2) Unit of Measure, (3) Element Number, (4) Specification and (5) Commentary. The second table details the condition state definitions which include the defects that apply to a particular element and the condition state language for each of those defects.

The Element Name is the name used to describe that particular element.

The Unit of Measure details the units to quantify that element. The Unit of Measure will be Length, Area or Each. Length should be reported in feet. Area should be reported in feet<sup>2</sup>.

The Element Number is the unique number assigned to represent that element. Element numbers were derived based on their section, subsection and element. All 1000 series elements are part of the structural or civil sections. All 2000 series elements are part of a functional system (ventilation, lighting, etc.). Additionally, the elements are further grouped by subsection. Tunnel liners of various materials are numbered 1000 through 1007, tunnel roof girders of various materials are numbered 1050 through 1053, etc.

The Specification and Commentary sections provide the detailed description of each element, how to calculate the quantity of the element and some explanation or additional clarification to consider for coding each element.

In addition to the elements defined herein, a State may define sub-elements that are consistent with these Specifications, which can provide additional information for their internal asset management needs. An example would be developing a sub-element for fan motors which can impact the effectiveness of the ventilation system. Alternatively, a State can develop state defined elements, which are not linked to an element defined within these Specifications so as to avoid confusion or inconsistency.

The Condition State Definition table lists defects and condition state language that is specific to that element. Only those defects which are appropriate for a specific element are listed. Each defect is then associated with four condition states and descriptive language based on the material type. This is done to recognize that the defect is dependent on the material and its severity. For instance cracking can occur in steel, concrete and timber, but the type of cracking will differ and the element condition state language reflects these differences. The severity of a defect can vary within an element, and is described and quantified using four different condition states.

- Condition State 1 is analogous to in good condition;
- Condition State 2 is analogous to in fair condition;
- Condition State 3 is analogous to in poor condition; and
- Condition State 4 is analogous to in severe condition.

The limits of Conditions States 1 through 3 are typically well defined for each defect. Condition State 4 is reserved for instances when the defect's conditions are beyond the limits of those defined in Conditions State 1 through 3 and a structural review is recommended or has been performed and reduced strength or serviceability exists.

For each element, the total quantity is divided among the 4 condition states based on the condition state languages. If a 10 ft long concrete girder were to be divided into 10 1-foot sections, each section would be assigned a condition state based on the defects present. If one 1-foot section had a crack .006 in. wide, that 1-foot section would be in condition state 2. If the remaining nine 1-foot sections had no problems, they would be in condition state 1. The result would be a total quantity of 10 ft, with 9 ft in condition state 1 and 1 ft in condition state 2.

## 3.2—Structural Section

## Structural Section

This section defines tunnel structural elements and the methodology for determining total element quantities and condition state quantities. The following elements are included.

Element #	Element Name	Unit of Measure
<b>Liners</b>		
1000	Steel Tunnel Liner	AREA (Feet <sup>2</sup> )
1001	Cast-in-Place Concrete Tunnel Liner	AREA (Feet <sup>2</sup> )
1002	Precast Concrete Tunnel Liner	AREA (Feet <sup>2</sup> )
1003	Shotcrete Tunnel Liner	AREA (Feet <sup>2</sup> )
1004	Timber Tunnel Liner	AREA (Feet <sup>2</sup> )
1005	Masonry Tunnel Liner	AREA (Feet <sup>2</sup> )
1006	Unlined Rock Tunnel	AREA (Feet <sup>2</sup> )
1007	Other Tunnel Liner	AREA (Feet <sup>2</sup> )
<b>Tunnel Roof Girders</b>		
1050	Steel Tunnel Roof Girders	LENGTH (Feet)
1051	Concrete Tunnel Roof Girders	LENGTH (Feet)
1052	Prestressed Concrete Tunnel Roof Girders	LENGTH (Feet)
1053	Other Tunnel Roof Girders	LENGTH (Feet)
<b>Columns/Piles</b>		
1100	Steel Columns/Piles	EACH
1101	Concrete Columns/Piles	EACH
1102	Other Columns/Piles	EACH
<b>Cross Passageway</b>		
1150	Steel Cross Passageway	LENGTH (Feet)
1151	Concrete Cross Passageway	LENGTH (Feet)
1152	Shotcrete Cross Passageway	LENGTH (Feet)
1153	Timber Cross Passageway	LENGTH (Feet)
1154	Masonry Cross Passageway	LENGTH (Feet)
1155	Unlined Rock Cross Passageway	LENGTH (Feet)
<b>Interior Walls</b>		
1200	Concrete Interior Walls	AREA (Feet <sup>2</sup> )
1201	Other Interior Walls	AREA (Feet <sup>2</sup> )
<b>Portal</b>		
1250	Concrete Portal	AREA (Feet <sup>2</sup> )
1251	Masonry Portal	AREA (Feet <sup>2</sup> )
1252	Other Portal	AREA (Feet <sup>2</sup> )

Element #	Element Name	Unit of Measure
	Ceiling Slab	
1300	Concrete Ceiling Slab	AREA (Feet <sup>2</sup> )
1301	Other Ceiling Slab	AREA (Feet <sup>2</sup> )
	Ceiling Girder	
1302	Steel Ceiling Girder	LENGTH (Feet)
1303	Concrete Ceiling Girder	LENGTH (Feet)
1304	Prestressed Concrete Ceiling Girder	LENGTH (Feet)
1305	Other Ceiling Girder	LENGTH (Feet)
	Hangers and Anchorages	
1400	Steel Hangers and Anchorages	EACH
1401	Other Hangers and Anchorages	EACH
	Ceiling Panels	
1410	Steel Ceiling Panels	AREA (Feet <sup>2</sup> )
1411	Concrete Ceiling Panels	AREA (Feet <sup>2</sup> )
1412	Other Ceiling Panels	AREA (Feet <sup>2</sup> )
	Invert Slab	
1500	Concrete Invert Slab	AREA (Feet <sup>2</sup> )
1501	Other Invert Slab	AREA (Feet <sup>2</sup> )
	Slab-on-Grade	
1510	Concrete Slab-on-Grade	AREA (Feet <sup>2</sup> )
1511	Other Slab-on-Grade	AREA (Feet <sup>2</sup> )
	Invert Girder	
1550	Steel Invert Girder	LENGTH (Feet)
1551	Concrete Invert Girder	LENGTH (Feet)
1552	Prestressed Concrete Invert Girder	LENGTH (Feet)
1553	Other Invert Girder	LENGTH (Feet)
	Joints	
1600	Strip Seal Expansion Joint	LENGTH (Feet)
1601	Pourable Joint Seal	LENGTH (Feet)
1602	Compression Joint Seal	LENGTH (Feet)
1603	Assembly Joint With Seal	LENGTH (Feet)
1604	Open Expansion Joint	LENGTH (Feet)
1605	Assembly Joint Without Seal	LENGTH (Feet)
	Gaskets	
1610	Gaskets	LENGTH (Feet)

<b><i>Steel Tunnel Liner</i></b>	
<u>Unit of Measure</u> Area (Feet <sup>2</sup> )	<u>Element Number</u> 1000
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all steel tunnel liners. Steel tunnel liners function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel.</p> <p>The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.</p>	<p>Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</p>

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Corrosion	None	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Cracking	None	Crack that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack exists that is not arrested but does not warrant structural review.	
Connections	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant a structural review.	
Distortion	None	Distortion not requiring mitigation or mitigated distortion.	Distortion that require mitigation that has not been addressed but does not warrant structural review.	
Leakage	Dry surface	Wet surface to less than 10 drips per minute.	10 to 30 drips per minute.	Greater than 30 drips per minute.

<b><i>Cast-in-Place Concrete Tunnel Liner</i></b>	
<u>Unit of Measure</u> Area (Feet <sup>2</sup> )	<u>Element Number</u> 1001
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all cast-in-place concrete tunnel liners. Cast-in place concrete tunnel liners function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel.</p> <p>The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.</p>	<p>Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</p>

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Delamination/ Spall/ Patched area	None	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Exposed Rebar	None	Present without measureable section loss.	Present with measureable section loss, but does not warrant structural review.	
Efflorescence/ Rust Staining	None	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking	Width less than 0.012 in. or spacing greater than 3.0 ft.	Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft.	Width greater than 0.05 in. or spacing of less than 1 ft.	
Distortion	None	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Leakage	Dry surface	Wet surface to less than 10 drips per minute.	10 to 30 drips per minute.	Greater than 30 drips per minute.

<b>Precast Concrete Tunnel Liner</b>	
<u>Unit of Measure</u> Area (Feet <sup>2</sup> )	<u>Element Number</u> 1002
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all precast concrete tunnel liners. Precast concrete tunnel liners function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel.</p> <p>The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.</p>	<p>Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</p>

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Delamination/ Spall/ Patched area	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Exposed Rebar	None	Present without measureable section loss.	Present with measureable section loss, but does not warrant structural review.	
Efflorescence/ Rust Staining	None	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking	Width less than 0.012 in. or spacing greater than 3.0 ft.	Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft.	Width greater than 0.05 in. or spacing of less than 1 ft.	
Distortion	None	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Leakage	Dry surface	Wet surface to less than 10 drips per minute.	10 to 30 drips per minute.	Greater than 30 drips per minute.

<b>Shotcrete Tunnel Liner</b>	
<u>Unit of Measure</u> Area (Feet <sup>2</sup> )	<u>Element Number</u> 1003
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all shotcrete tunnel liners. Shotcrete tunnel liners function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel.</p> <p>The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.</p>	<p>Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</p>

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Delamination/ Spall/ Patched area	None	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Exposed Rebar	None	Present without measureable section loss.	Present with measureable section loss, but does not warrant structural review.	
Efflorescence/ Rust Staining	None	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking	Width less than 0.012 in. or spacing greater than 3.0 ft.	Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft.	Width greater than 0.05 in. or spacing of less than 1 ft.	
Distortion	None	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Leakage	Dry surface	Wet surface to less than 10 drips per minute.	10 to 30 drips per minute.	Greater than 30 drips per minute.

<b>Timber Tunnel Liner</b>	
<u>Unit of Measure</u> Area (Feet <sup>2</sup> )	<u>Element Number</u> 1004
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all timber tunnel liners. Timber tunnel liners function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel.</p> <p>The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.</p>	Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Connection	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Decay/Section Loss	None	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5% - 50% of the thickness of the member and is not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant a structural analysis.	
Crack	None	Crack than has been arrested through effective measures.	Identified crack exists that is not arrested, but does not require structural review.	
Split/Delamination	None	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth, but does not warrant structural review.	

### Condition State Definitions Cont.

<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Distortion	None	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Leakage	Dry surface	Wet surface to less than 10 drips per minute.	10 to 30 drips per minute.	Greater than 30 drips per minute.

<b><i>Masonry Tunnel Liner</i></b>	
<u>Unit of Measure</u> Area (Feet <sup>2</sup> )	<u>Element Number</u> 1005
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all masonry tunnel liners. Masonry tunnel liners function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel.</p> <p>The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.</p>	Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Efflorescence/ Rust Staining	None	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Mortar Breakdown	None	Cracking or voids in less than 10% of joints.	Cracking or voids in 10% or more of the joints.	
Split/Spall	None	Block or stone has split or spalled with no shifting.	Block or stone has split or spalled with shifting but does not warrant a structural review.	
Patched Area	None	Sound patch.	Unsound patch.	
Masonry Displacement	None	Block or stone has shifted slightly out of alignment.	Block or stone has shifted significantly out of alignment or is missing but does not warrant structural review.	
Distortion	None	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Leakage	Dry surface	Wet surface to less than 10 drips per minute.	10 to 30 drips per minute.	Greater than 30 drips per minute.

<b><i>Unlined Rock Tunnel</i></b>	
<u>Unit of Measure</u> Area (Feet <sup>2</sup> )	<u>Element Number</u> 1006
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all unlined rock tunnels. Unlined rock tunnels function as the exterior of the tunnel and as a divider between different bores of the tunnel.</p> <p>The area of an unlined rock tunnel is the product of the length of the tunnel (along the centerline) and the perimeter of the unlined rock.</p>	Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Loose or Cracked Rock	Cracks are present but have not allowed the rock to shift.	Cracks are present and areas of loose rock are less than 1 ft <sup>2</sup> .	Cracked with areas of loose rock greater than 1 ft <sup>2</sup> .	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Roof Bolt Distress	Roof bolt is in place and functioning as intended.	Loose nuts are present but the bolts are in place and functioning as intended.	Missing nuts or broken bolts but does not warrant a structural review.	
Patched Areas	None	Sound patches.	Unsound patches.	
Leakage	Dry surface	Wet surface to less than 10 drips per minute.	10 to 30 drips per minute.	Greater than 30 drips per minute.

<b><i>Other Tunnel Liner</i></b>	
<u>Unit of Measure</u> Area (Feet <sup>2</sup> )	<u>Element Number</u> 1007
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all tunnel liners composed of other materials. Other tunnel liners function as a shell for the exterior of the tunnel and as a divider between different bores of the tunnel.</p> <p>The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.</p>	Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Cracking	Cracks are present but have not allowed the rock to shift.	Cracks are present and rock has minor shifting.	Rocks are cracked with face deformation. Rocks are missing.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Distortion	None	Distortion not requiring mitigation or mitigated distortion.	Distortion requires mitigation that has not been addressed but does not warrant structural review.	
Patched Areas	None	Sound patches.	Unsound patches.	
Leakage	Dry surface	Wet surface to less than 10 drips per minute.	10 to 30 drips per minute.	Greater than 30 drips per minute.

<b>Steel Tunnel Roof Girder</b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1050
<u>Specification</u>	<u>Commentary</u>
Record this element for all steel tunnel roof girders. Tunnel roof girders support the tunnel roof liner or exposed rock which constitutes the tunnel roof.  The total length of tunnel roof girder is the sum of all the lengths of each tunnel roof girder.	Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Corrosion	None	Freckled rust. Corrosion of steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Cracking	None	Crack that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack exists that is not arrested but does not warrant structural review.	
Connections	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant a structural review.	
Distortion	None	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed, but does not warrant structural review.	

<b>Concrete Tunnel Roof Girder</b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1051
<u>Specification</u>	<u>Commentary</u>
Record this element for all concrete tunnel roof girders. Tunnel roof girders support the tunnel roof liner or exposed rock which constitutes the tunnel roof.  The total length of tunnel roof girder is the sum of all the lengths of each tunnel roof girder.	Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Delamination/ Spall/ Patched area	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Exposed Rebar	None	Present without measureable section loss.	Present with measureable section loss, but does not warrant structural review.	
Efflorescence/ Rust Staining	None	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking	Width less than 0.012 in. or spacing greater than 3.0 ft.	Width 0.012 - 0.05 in. or spacing of 1 – 3.0 ft.	Width greater than 0.05 in. or spacing of less than 1 ft.	

<b><i>Prestressed Concrete Tunnel Roof Girder</i></b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1052
<u>Specification</u>	<u>Commentary</u>
Record this element for all prestressed concrete tunnel roof girders. Tunnel roof girders support the tunnel roof liner or exposed rock which constitutes the tunnel roof.  The total length of tunnel roof girder is the sum of all the lengths of each tunnel roof girder.	Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Delamination/ Spall/ Patched area	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Exposed Rebar	None	Present without measureable section loss.	Present with measureable section loss, but does not warrant structural review.	
Exposed Prestressing	None	Present without section loss.	Present with section loss, but does not warrant structural review.	
Cracking	Width less than 0.004 in. or spacing greater than 3 ft.	Width 0.004 - 0.009 in. or spacing of 1.0 - 3.0 ft.	Width greater than 0.009 in. or spacing less than 1 ft.	
Efflorescence/ Rust Staining	None	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	

<b><i>Other Tunnel Roof Girder</i></b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1053
<u>Specification</u>	<u>Commentary</u>
Record this element for all tunnel roof girders composed of other materials. Tunnel roof girders support the tunnel roof liner or exposed rock which constitutes the tunnel roof.  The total length of tunnel roof girder is the sum of all the lengths of each tunnel roof girder.	Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
General Condition	Good condition – no notable distress	Fair condition- isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.

<b>Steel Column/Pile</b>	
<u>Unit of Measure</u> Each	<u>Element Number</u> 1100
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all steel columns/piles. Tunnel columns support the tunnel roof girders, tunnel ceiling girders tunnel invert girders. Tunnel piles provide support for the tunnel columns.</p> <p>The total number of columns/piles is the sum of all the number of columns and piles.</p>	<p>Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</p> <p>The majority of the columns/piles will be below grade and therefore not visible for inspection.</p>

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Corrosion	None	Freckled rust. Corrosion of steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Cracking	None	Cracks that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack exists that is not arrested but does not require structural review.	
Connection	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant structural review.	
Distortion	None	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed, but does not warrant structural review.	

<b>Concrete Column/Pile</b>	
<u>Unit of Measure</u> Each	<u>Element Number</u> 1101
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all concrete columns/piles. Tunnel columns support the tunnel roof girders, tunnel ceiling girders tunnel invert girders. Tunnel piles provide support for the tunnel columns.</p> <p>The total number of columns/piles is the sum of all the number of columns and piles.</p>	<p>Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</p> <p>The majority of the columns/piles will be below grade and therefore not visible for inspection.</p>

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Delamination/ Spall/ Patched area	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Exposed Rebar	None	Present without measureable section loss.	Present with measureable section loss, but does not warrant structural review.	
Efflorescence/ Rust Staining	None	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking	Width less than 0.012 in. or spacing greater than 3.0 ft.	Width 0.012 - 0.05 in. or spacing of 1 – 3.0 ft.	Width greater than 0.05 in. or spacing of less than 1 ft.	

<b>Other Column/Pile</b>	
<u>Unit of Measure</u> Each	<u>Element Number</u> 1102
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all columns/piles composed of other material. Tunnel columns support the tunnel roof girders, tunnel ceiling girders tunnel invert girders. Tunnel piles provide support for the tunnel columns.</p> <p>The total number of columns/piles is the sum of all the number of columns and piles.</p>	<p>Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</p> <p>The majority of the columns/piles will be below grade and therefore not visible for inspection.</p>

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
General Condition	Good condition – no notable distress	Fair condition- isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.

<b>Steel Cross Passageway</b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1150
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all steel cross passageways. Cross passageways are typically oriented transverse to the tunnel bores, and are comprised of doors to allow egress between separated tunnel bores.</p> <p>The total length of cross passageways is the sum of all of the lengths of each cross passageway.</p>	<p>Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</p>

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Corrosion	None	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Cracking	None	Crack that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack exists that is not arrested but does not require structural review.	
Connections	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant a structural review.	
Distortion	None	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Leakage	Dry surface	Wet surface to less than 10 drips per minute.	10 to 30 drips per minute.	Greater than 30 drips per minute.

<b>Concrete Cross Passageway</b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1151
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all concrete cross passageways. Cross passageways are typically oriented transverse to the tunnel bores, and are comprised of doors to allow egress between separated tunnel bores.</p> <p>The total length of cross passageways is the sum of all of the lengths of each cross passageway.</p>	Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Delamination/ Spall/ Patched area	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Exposed Rebar	None	Present without measureable section loss.	Present with measureable section loss, but does not warrant structural review.	
Efflorescence/ Rust Staining	None	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking Sizes	Width less than 0.012 in. or spacing greater than 3.0 ft.	Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft.	Width greater than 0.05 in. or spacing of less than 1 ft.	
Distortion	None	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	Greater than 30 drips per minute.
Leakage	Dry surface	Wet surface to less than 10 drips per minute.	10 to 30 drips per minute.	

<b><i>Shotcrete Cross Passageway</i></b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1152
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all shotcrete cross passageways. Cross passageways are typically oriented transverse to the tunnel bores, and are comprised of doors to allow egress between separated tunnel bores.</p> <p>The total length of cross passageways is the sum of all of the lengths of each cross passageway.</p>	<p>Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</p>

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Delamination/ Spall/ Patched area	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Exposed Rebar	None	Present without measureable section loss.	Present with measureable section loss, but does not warrant structural review.	
Efflorescence/ Rust Staining	None	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking Sizes	Width less than 0.012 in. or spacing greater than 3.0 ft.	Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft.	Width greater than 0.05 in. or spacing of less than 1 ft.	
Distortion	None	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Leakage	Dry surface	Wet surface to less than 10 drips per minute.	10 to 30 drips per minute.	Greater than 30 drips per minute.

<b><i>Timber Cross Passageway</i></b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1153
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all timber cross passageways. Cross passageways are typically oriented transverse to the tunnel bores, and are comprised of doors to allow egress between separated tunnel bores.</p> <p>The total length of cross passageways is the sum of all of the lengths of each cross passageway.</p>	<p>Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</p>

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Connection	Connection is in place and functioning as intended.	Loose fastener or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Decay/Section Loss	None	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5% - 50% of the thickness of the member and is not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural analysis.	
Cracks	None	Cracks than have been arrested through effective measures.	Identified crack exists that is not arrested but does not require structural review.	
Split/Delamination	None	Length less than member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth, but does not require structural review.	

<b>Condition State Definitions Cont.</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Distortion	None	Distortion not requiring mitigation or mitigated distortion.	Distortion that require mitigation that has not been addressed but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel
Leakage	Dry surface	Wet surface to less than 10 drips per minute.	10 to 30 drips per minute.	Greater than 30 drips per minute.

<b><i>Masonry Cross Passageway</i></b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1154
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all masonry cross passageways. Cross passageways are typically oriented transverse to the tunnel bores, and are comprised of doors to allow egress between separated tunnel bores.</p> <p>The total length of cross passageways is the sum of all of the lengths of each cross passageway.</p>	Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Efflorescence/ Rust Staining	None	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	The condition warrants a structural review to determine the affect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Mortar Breakdown	None	Cracking or voids in less than 10% of joints.	Cracking or voids in 10% or more of the joints.	
Split/Spall	None	Block or stone has split or spalled with no shifting.	Block or stone has split or spalled with shifting but does not warrant a structural review.	
Patched Areas	None	Sound patch.	Unsound patch.	
Masonry Displacement	None	Block or stone has shifted slightly out of alignment.	Block or stone has shifted significantly out of alignment or is missing but does not warrant structural review.	
Distortion	None	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Leakage	Dry surface	Wet surface to less than 10 drips per minute.	10 to 30 drips per minute.	Greater than 30 drips per minute.

<b><i>Unlined Rock Cross Passageway</i></b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1155
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all unlined rock cross passageways. Cross passageways are typically oriented transverse to the tunnel bores, and are comprised of doors to allow egress between separated tunnel bores.</p> <p>The total length of cross passageways is the sum of all of the lengths of each cross passageway.</p>	Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Loose or Cracked Rock	Cracks are present but have not allowed the rock to shift.	Cracks are present and areas of loose rock are less than 1 ft <sup>2</sup> .	Cracked with areas of loose rock greater than 1 ft <sup>2</sup> .	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Roof Bolt Distress	Roof bolt is in place and functioning as intended.	Loose nuts are present but the bolts are in place and functioning as intended.	Missing nuts or broken bolts but does not warrant a structural review.	
Patched Areas	None	Sound patches.	Unsound patches.	
Leakage	Dry surface	Wet surface to less than 10 drips per minute.	10 to 30 drips per minute.	Greater than 30 drips per minute.

<b>Concrete Interior Walls</b>	
<u>Unit of Measure</u> Area (Feet <sup>2</sup> )	<u>Element Number</u> 1200
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all concrete interior walls. This element defines those internal walls in tunnels which are usually placed to separate traffic travelling in opposite directions. The internal wall also serves as a barrier between tunnel segments in an emergency to protect evacuees from smoke inhalation, fire or hazardous conditions.</p> <p>The area of the interior wall is the product of the length (along the centerline) of the tunnel and the height.</p>	<p>Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</p>

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Delamination/ Spall/ Patched area	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Exposed Rebar	None	Present without section loss.	Present with measureable section loss, but does not warrant structural review.	
Efflorescence/ Rust Staining	None	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking	Width less than 0.012 in. or spacing greater than 3.0 ft.	Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft.	Width greater than 0.05 in. or spacing of less than 1 ft.	

<b><i>Other Interior Walls</i></b>	
<u>Unit of Measure</u> Area (Feet <sup>2</sup> )	<u>Element Number</u> 1201
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all interior walls composed of other materials. This element defines those internal walls in tunnels which are usually placed to separate traffic travelling in opposite directions. The internal wall also serves as a barrier between tunnel segments in an emergency to protect evacuees from smoke inhalation, fire or hazardous conditions.</p> <p>The area of the interior wall is the product of the length (along the centerline) of the tunnel and the height.</p>	<p>Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</p>

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
General Condition	Good condition – no notable distress	Fair condition- isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.

<b>Concrete Portal</b>	
<u>Unit of Measure</u> Area (Feet <sup>2</sup> )	<u>Element Number</u> 1250
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all concrete portals. This element defines the portal façade, which comprise the architectural/structural elements that are above the roadway at the opening of the tunnel bore.</p> <p>The area of the portal is the product of the width and height of the portal minus the area of the roadway opening. The area may include wingwalls which retain soil and rock near the portal but does not include walls leading up to the portal.</p>	<p>Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</p>

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Delamination/ Spall/ Patched area	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Exposed Rebar	None	Present without measureable section loss.	Present with measureable section loss, but does not warrant structural review.	
Efflorescence/ Rust Staining	None	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking	Width less than 0.012 in. or spacing greater than 3 ft.	Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft.	Width greater than 0.05 in. or spacing of less than 1 ft.	
Settlement	None	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	

<b><i>Masonry Portal</i></b>	
<u>Unit of Measure</u> Area (Feet <sup>2</sup> )	<u>Element Number</u> 1251
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all masonry portals. This element defines the portal façade, which comprise the architectural/structural elements that are above the roadway at the opening of the tunnel bore.</p> <p>The area of the portal is the product of the width and height of the portal minus the area of the roadway opening. The area may include wingwalls which retain soil and rock near the portal but does not include walls leading up to the portal.</p>	<p>Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</p>

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Efflorescence/ Rust Staining	None	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Mortar Breakdown	None	Cracking or voids in less than 10% of joints.	Cracking or voids in 10% or more of the joints.	
Split/Spall	None	Block or stone has split or spalled with no shifting.	Block or stone has split or spalled with shifting but does not warrant a structural review.	
Patched Area	None	Sound patch.	Unsound patch.	
Masonry Displacement	None	Block or stone has shifted slightly out of alignment.	Block or stone has shifted significantly out of alignment or is missing but does not warrant structural review.	
Settlement	None	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	

<b>Other Portal</b>	
<u>Unit of Measure</u> Area (Feet <sup>2</sup> )	<u>Element Number</u> 1252
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all portals composed of other materials. This element defines the portal façade, which comprise the architectural/structural elements that are above the roadway at the opening of the tunnel bore.</p> <p>The area of the portal is the product of the width and height of the portal minus the area of the roadway opening. The area may include wingwalls which retain soil and rock near the portal but does not include walls leading up to the portal.</p>	<p>Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</p>

<u>Condition State Definitions</u>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
General Condition	Good condition – no notable distress	Fair condition- isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Settlement	None	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	

<b>Concrete Ceiling Slab</b>	
<u>Unit of Measure</u> Area (Feet <sup>2</sup> )	<u>Element Number</u> 1300
<u>Specification</u>	<u>Commentary</u>
Record this element for all concrete ceiling slabs. This element defines those structural slabs which separate the space above the roadway from the upper plenum.  The area of the ceiling slab is the product of the width length of the slab.	Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.  The roof of a tunnel would be considered part of the tunnel liner.

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Delamination/ Spall/ Patched area	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Exposed Rebar	None	Present without measureable section loss.	Present with measureable section loss, but does not warrant structural review.	
Efflorescence	None	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking	Width less than 0.012 in. or spacing greater than 3.0 ft.	Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft.	Width greater than 0.05 in. or spacing less than 1 ft.	

<b>Other Ceiling Slab</b>	
<u>Unit of Measure</u> Area (Feet <sup>2</sup> )	<u>Element Number</u> 1301
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all ceiling slabs composed of other materials. This element defines those structural slabs which separate the space above the roadway from the upper plenum.</p> <p>The area of the ceiling slab is the product of the width length of the slab.</p>	<p>Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</p> <p>The roof would of a tunnel be considered part of the tunnel liner.</p>

<u>Condition State Definitions</u>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
General Condition	Good condition – no notable distress	Fair condition- isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.

<b>Steel Ceiling Girder</b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1302
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all steel ceiling girders. This element defines the girders that support the structural ceiling slabs which separate the space above the roadway from the upper plenum.</p> <p>The total quantity for ceiling girder is the sum of all the lengths of each tunnel ceiling girder.</p>	<p>Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</p>

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Corrosion	None	Freckled rust. Corrosion of steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Cracking	None	Crack that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack exists that is not arrested but does not warrant structural review.	
Connection	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant a structural review.	
Distortion	None	Distortion not requiring mitigation or mitigating distortion.	Distortion that requires mitigation that has not been addressed but does not require structural review.	

<b>Concrete Ceiling Girder</b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1303
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all concrete ceiling girders. This element defines the girders that support the structural ceiling slabs which separate the space above the roadway from the upper plenum.</p> <p>The total quantity for ceiling girder is the sum of all the lengths of each tunnel ceiling girder.</p>	<p>Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</p>

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Delamination/ Spall/ Patched area	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Exposed Rebar	None	Present without measureable section loss.	Present with measureable section loss, but does not warrant structural review.	
Efflorescence/ Rust Staining	None	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking	Width less than 0.012 in. or spacing greater than 3.0 ft.	Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft.	Width greater than 0.05 in. or spacing less than 1 ft.	

<b><i>Prestressed Concrete Ceiling Girder</i></b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1304
<u>Specification</u>	<u>Commentary</u>
Record this element for all prestressed concrete ceiling girders. This element defines the girders that support the structural ceiling slabs which separate the space above the roadway from the upper plenum.  The total quantity for ceiling girder is the sum of all the lengths of each tunnel ceiling girder.	Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Delamination/ Spall/ Patched area	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Exposed Rebar	None	Present without measureable section loss.	Present with measureable section loss, but does not warrant structural review.	
Exposed Prestressing	None	Present without section loss.	Present with section loss, but does not warrant structural review.	
Cracking	Width less than 0.004 in. or spacing greater than 3 ft.	Width 0.004 - 0.009 in. or spacing of 1.0 – 3.0 ft.	Width greater than 0.009 in. or spacing less than 1 ft.	
Efflorescence/ Rust Staining	None	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	

<b>Other Ceiling Girder</b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1305
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all ceiling girders composed of other materials. This element defines the girders that support the structural ceiling slabs which separate the space above the roadway from the upper plenum.</p> <p>The total quantity for ceiling girder is the sum of all the lengths of each tunnel ceiling girder.</p>	<p>Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</p>

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
General Condition	Good condition – no notable distress	Fair condition- isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.

<b><i>Steel Hangers and Anchorages</i></b>	
<u>Unit of Measure</u> Each	<u>Element Number</u> 1400
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all steel hangers and anchorages. Hangers are tension members that support ceiling girders or ceiling panels. The anchorages of the hangers are typically attached to the tunnel roof and ceiling panels.</p> <p>The total quantity for hangers and anchorages is the sum of all the number of hanger and anchorage units.</p>	<p>Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</p> <p>Distress observed on either hanger or anchorage should be considered in the condition assessment. Ultrasonic testing results should be taken into consideration in the condition assessment if available.</p>

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Corrosion	None	Freckled rust. Corrosion of steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Cracking	None	Crack that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack exists that is not arrested but does not warrant a structural review.	
Connections	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant a structural review.	
Distortion (Shortening and Lengthening)	None	Isolated hangers are slightly bowed or elongated.	Anchors attaching isolated hangers to the overhead structure have a gap <1/8" or are visibly elongated.	

### Condition State Definitions Cont.

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Creep	No displacement of anchor material.	Minor displacement.	Displacement of anchor material, but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Anchorage area	Sound anchorage.	Cracking around anchorage areas, but concrete is sound.	Cracking or spalling around anchorage area and concrete is not sound.	

<b><i>Other Hangers and Anchorages</i></b>	
<u>Unit of Measure</u> Each	<u>Element Number</u> 1401
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all hangers and anchorages composed of other materials. Hangers are tension members that support ceiling girders or ceiling panels. The anchorages of the hangers are typically attached to the tunnel roof and ceiling panels.</p> <p>The total quantity for hangers and anchorages is the sum of all the number of hanger and anchorage units.</p>	<p>Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</p> <p>Distress observed on either hanger or anchorage should be considered in the condition assessment. Ultrasonic testing results should be taken into consideration in the condition assessment if available.</p>

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
General Condition	Good condition – no notable distress	Fair condition- isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Connections	Sound	Isolated fasteners are loose at their connections.	Adjacent hangers are loose. Fasteners are missing from adjacent hanger connections at isolated locations.	
Distortion (Shortening and Lengthening)	None	Isolated hangers are slightly bowed or elongated.	Anchors attaching isolated hangers to the overhead structure have a gap <1/8" or are visibly elongated.	
Creep	No displacement of anchor material.	Minor displacement.	Displacement of anchor material, but does not warrant a structural review.	
Anchorage area	Sound anchorage.	Cracking around anchorage areas, but concrete is sound.	Cracking or spalling around anchorage area and concrete is not sound.	

<b>Steel Ceiling Panels</b>	
<u>Unit of Measure</u> Area (Feet <sup>2</sup> )	<u>Element Number</u> 1410
<u>Specification</u>	<u>Commentary</u>
Record this element for all steel ceiling panels. Ceiling panels separate the upper plenum from space above the tunnel roadway. Ceiling panels are typically supported by hangers.  The area of the ceiling panel is the product of the width and length of the panel.	Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Corrosion	None	Freckled rust. Corrosion of steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Cracking	None	Crack that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack exists that is not arrested but does not warrant a structural review.	
Connection	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant a structural review.	
Distortion	None	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not require structural review.	

<b>Concrete Ceiling Panels</b>	
<u>Unit of Measure</u> Area (Feet <sup>2</sup> )	<u>Element Number</u> 1411
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all concrete ceiling panels. Ceiling panels separate the upper plenum from space above the tunnel roadway. Ceiling panels are typically supported by hangers.</p> <p>The area of the ceiling panel is the product of the width and length of the panel.</p>	<p>Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</p>

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Delamination/ Spall/ Patched area	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Exposed Rebar	None	Present without measureable section loss.	Present with measureable section loss, but does not warrant structural review.	
Efflorescence/ Rust Staining	None	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking	Width less than 0.012 in. or spacing greater than 3.0 ft.	Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft.	Width greater than 0.05 in. or spacing less than 1 ft.	

<b>Other Ceiling Panels</b>	
<u>Unit of Measure</u> Area (Feet <sup>2</sup> )	<u>Element Number</u> 1412
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all ceiling panels composed of other materials. Ceiling panels separate the upper plenum from space above the tunnel roadway. Ceiling panels are typically supported by hangers.</p> <p>The area of the ceiling panel is the product of the width and length of the panel.</p>	<p>Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</p>

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
General Condition	Good condition – no notable distress	Fair condition- isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.

<b>Concrete Invert Slab</b>	
<u>Unit of Measure</u> Area (Feet <sup>2</sup> )	<u>Element Number</u> 1500
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all concrete invert slabs. This element defines those structural slabs which support the roadway and traffic loads.</p> <p>The total area of the invert slab is the product of the width and length of the slab.</p>	<p>Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</p> <p>The slab evaluation is three dimensional with the defects observed on the top surface, bottom surface, or both, and being captured using the defined condition states. Slab top or bottom surfaces that are not visible for inspection shall be assessed based on the available visible surface. If both top and bottom surfaces are not visible, the condition shall be assessed based on destructive and nondestructive testing or indicators in the materials covering the surfaces.</p>

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Delamination/ Spall/ Patched area	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Exposed Rebar	None	Present without measureable section loss.	Present with measureable section loss, but does not warrant structural review.	
Efflorescence/ Rust Staining	None	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking	Width less than 0.012 in. or spacing greater than 3.0 ft.	Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft.	Width greater than 0.05 in. or spacing less than 1 ft.	

<b><i>Other Invert Slab</i></b>	
<u>Unit of Measure</u> Area (Feet <sup>2</sup> )	<u>Element Number</u> 1501
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all invert slabs composed of other materials. This element defines those structural slabs which support the roadway and traffic loads.</p> <p>The total area of the invert slab is the product of the width and length of the slab.</p>	<p>Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</p> <p>The slab evaluation is three dimensional with the defects observed on the top surface, bottom surface, or both, and being captured using the defined condition states. Slab top or bottom surfaces that are not visible for inspection shall be assessed based on the available visible surface. If both top and bottom surfaces are not visible, the condition shall be assessed based on destructive and nondestructive testing or indicators in the materials covering the surfaces.</p>

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
General Condition	Good condition – no notable distress	Fair condition- isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.

<b>Concrete Slab-on-Grade</b>	
<u>Unit of Measure</u> Area (Feet <sup>2</sup> )	<u>Element Number</u> 1510
<u>Specification</u>	<u>Commentary</u>
Record this element for all concrete slabs-on-grade. This element defines a slab that is supported continuously on a subbase material.  The area of the slab-on-grade is the product of the width and length of the.	Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Delamination/ Spall/ Patched area	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Exposed Rebar	None	Present without measureable section loss.	Present with measureable section loss, but does not warrant structural review.	
Cracking	Width less than 0.012 in. or spacing greater than 3.0 ft.	Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft.	Width greater than 0.05 in. or spacing of less than 1 ft.	
Settlement	None	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	

<b>Other Slab-on-Grade</b>	
<u>Unit of Measure</u> Area (Feet <sup>2</sup> )	<u>Element Number</u> 1511
<u>Specification</u>	<u>Commentary</u>
Record this element for all slabs-on-grade composed of other materials. This element defines a slab that is supported continuously on a subbase material.  The area of the slab-on-grade is the product of the width and length of the.	Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
General Condition	Good condition – no notable distress	Fair condition- isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Settlement	None	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	

<b><i>Steel Invert Girder</i></b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1550
<u>Specification</u>	<u>Commentary</u>
Record this element for all steel invert girders. This element defines the invert girders which support the invert slabs.  The total quantity for invert girder is the sum of all the lengths of each invert girder.	Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Corrosion	None	Freckled rust. Corrosion of steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Cracking	None	Crack that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack exists that is not arrested but does not warrant structural review.	
Connection	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant a structural review.	
Distortion	None	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not require structural review.	

<b>Concrete Invert Girder</b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1551
<u>Specification</u>	<u>Commentary</u>
Record this element for all concrete invert girders. This element defines the invert girders which support the invert slabs.  The total quantity for invert girder is the sum of all the lengths of each invert girder.	Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Delamination/ Spall/ Patched area	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Exposed Rebar	None	Present without measureable section loss.	Present with measureable section loss, but does not warrant structural review.	
Efflorescence	None	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking	Width less than 0.012 in. or spacing greater than 3.0 ft.	Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft.	Width greater than 0.05 in. or spacing less than 1 ft.	

<b><i>Prestressed Concrete Invert Girder</i></b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1552
<u>Specification</u>	<u>Commentary</u>
Record this element for all prestressed concrete invert girders. This element defines the invert girders which support the invert slabs.  The total quantity for invert girder is the sum of all the lengths of each invert girder.	Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Delamination/ Spall/ Patched area	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Exposed Rebar	None	Present without measureable section loss.	Present with measureable section loss, but does not warrant structural review.	
Exposed Prestressing	None	Present without section loss.	Present with section loss, but does not warrant structural review.	
Cracking	Width less than 0.004 in. or spacing greater than 3 ft.	Width 0.004 - 0.009 in. or spacing of 1.0 – 3.0 ft.	Width greater than 0.009 in. or spacing less than 1 ft.	
Efflorescence/ Rust Staining	None	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	

<b>Other Invert Girder</b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1553
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all invert girders composed of other materials. This element defines the invert girders which support the invert slabs.</p> <p>The total quantity for invert girder is the sum of all the lengths of each invert girder.</p>	<p>Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</p>

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
General Condition	Good condition – no notable distress	Fair condition – isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.

<b><i>Strip Seal Expansion Joint</i></b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1600
<u>Specification</u>	<u>Commentary</u>
Record this element for all strip seal expansion joints. This element defines those expansion joint devices which utilize a neoprene type waterproof gland with some type of metal extrusion or other system to anchor the gland.  The total quantity for expansion joints is the sum of all the lengths of each joint.	

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Leakage	None	Minimal. Minor dripping through the joint.	Moderate. More than a drip and less than free flow of water.	Free flow of water through the joint.
Seal Adhesion	Fully adhered.	Adhered for more than 50% of the joint height.	Adhered 50% or less of the joint height but still some adhesion.	Complete loss of adhesion.
Seal Damage	None	Seal abrasion without punctures.	Punctured or ripped or partially pulled out.	Punctured completely through, pulled out, or missing.
Seal cracking	None	Surface crack.	Crack that partially penetrates the seal.	Crack that fully penetrates the seal.
Debris Impaction	No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint.	Partially filled with hard-packed material, but still allowing free movement.	Completely filled and impacts joint movement.	Completely filled and prevents joint movement.
Adjacent Deck or Header	Sound. No spall, delamination or unsound patch.	Edge delamination or spall 1 in. or less deep or 6 in. or less in diameter. No exposed rebar. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall, delamination, unsound patched area or loose joint anchor that prevents the joint from functioning as intended.

### Condition State Definitions Cont.

<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Metal Deterioration or Damage	None	Freckled rust, metal has no cracks, or impact damage. Connections may be loose but functioning as intended.	Section loss, missing or broken fasteners, cracking of the metal or impact damage but joint is still functioning.	Metal cracking, section loss, damage or connection failure that prevents the joint from functioning as intended.

<b><i>Pourable Joint Seal</i></b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1601
<u>Specification</u>	<u>Commentary</u>
Record this element for all pourable joint seals. This element defines those joints filled with a pourable seal with or without a backer.  The total quantity for expansion joints is the sum of all the lengths of each joint.	

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Leakage	None	Minimal. Minor dripping through the joint.	Moderate. More than a drip and less than free flow of water.	Free flow of water through the joint.
Seal Adhesion	Fully adhered.	Adhered for more than 50% of the joint height.	Adhered 50% or less of the joint height but still some adhesion.	Complete loss of adhesion.
Seal Damage	None	Seal abrasion without punctures.	Punctured or ripped or partially pulled out.	Punctured completely through, pulled out, or missing.
Seal Cracking	None	Surface crack.	Crack that partially penetrates the seal.	Crack that fully penetrates the seal.
Debris Impaction	No debris to shallow cover of loose debris may be evident but does not affect the performance of the joint.	Partially filled with hard-packed material, but still allowing free movement.	Completely filled and impacts joint movement.	Completely filled and prevents joint movement.
Adjacent Deck or Header	Sound. No spall, delamination or unsound patch.	Edge delamination or spall 1 in. or less deep or 6 in. or less in diameter. No exposed rebar. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall, delamination, unsound patched area or loose joint anchor that prevents the joint from functioning as intended.

<b>Compression Joint Seal</b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1602
<u>Specification</u>	<u>Commentary</u>
Record this element for all compression joint seals. This element defines those joints filled with a preformed compression type seal. This joint does not have an anchor system to confine the seal.  The total quantity for expansion joints is the sum of all the lengths of each joint.	

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Leakage	None	Minimal. Minor dripping through joints.	Moderate. More than a drip and less than free flow of water.	Free flow of water through the joint.
Seal Adhesion	Fully adhered.	Adhered for more than 50% of the joint height.	Adhered 50% or less of the joint height but still some adhesion.	Complete loss of adhesion.
Seal Damage	None	Seal abrasion without punctures.	Punctured or ripped or partially pulled out.	Punctured completely through, pulled out, or missing.
Seal Cracking	None	Surface crack.	Crack that partially penetrates the seal.	Crack that fully penetrates the seal.
Debris Impaction	No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint.	Partially filled with hard-packed material, but still allowing free movement.	Completely filled and impacts joint movement.	Completely filled and prevents joint movement.
Adjacent Deck or Header	Sound. No spall, delamination or unsound patch.	Edge delamination or spall 1 in. or less deep or 6 in. or less in diameter. No exposed rebar. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall, delamination, unsound patched area or loose joint anchor that prevents the joint from functioning as intended.

<b><i>Assembly Joint with Seal</i></b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1603
<u>Specification</u>	<u>Commentary</u>
Record this element for all assembly joints with seals. This element defines only those joints filled with an assembly mechanism that have a seal.  The total quantity for expansion joints is the sum of all the lengths of each joint.	

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Leakage	None	Minimal. Minor dripping through joints.	Moderate. More than a drip and less than free flow of water.	Free flow of water through the joint.
Seal Adhesion	Fully adhered.	Adhered for more than 50% of the joint height.	Adhered 50% or less of joint height but still some adhesion.	Complete loss of adhesion.
Seal Damage	None	Seal abrasion without punctures.	Punctured or ripped or partially pulled out.	Punctured completely through, pulled out, or missing.
Seal Cracking	None	Surface crack.	Crack that partially penetrates the seal.	Crack that fully penetrates the seal.
Debris Impaction	No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint.	Partially filled with hard-packed material, but still allowing free movement.	Completely filled and impacts joint movement.	Completely filled and prevents joint movement.
Adjacent Deck or Header	Sound. No spall, delamination or unsound patch.	Edge delamination or spall 1 in. or less or 6 in. or less in diameter. No exposed rebar. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall, delamination, unsound patched area or loose joint anchor that prevents the joint from functioning as intended.

### Condition State Definitions Cont.

<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Metal Deterioration or Damage	None	Freckled rust, metal has no cracks, or impact damage. Connections may be loose but functioning as intended.	Section loss, missing or broken fasteners, cracking of the metal or impact damage but joint is still functioning.	Metal cracking, section loss, damage or connection failure that prevents the joint from functioning as intended.

<b><i>Open Expansion Joint</i></b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1604
<u>Specification</u>	<u>Commentary</u>
Record this element for all open expansion joints. This element defines only those joints that are open and not sealed.  The total quantity for expansion joints is the sum of all the lengths of each joint.	

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Debris Impaction	No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint.	Partially filled with hard-packed material, but still allowing free movement.	Completely filled and impacts joint movement.	Completely filled and prevents joint movement.
Adjacent Deck or Header	Sound. No spall, delamination or unsound patch.	Edge delamination or spall 1 in. or less or 6 in. or less in diameter. No exposed rebar. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall, delamination, unsound patched area or loose joint anchor that prevents the joint from functioning as intended.

<b><i>Assembly Joint without Seal</i></b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1605
<u>Specification</u>	<u>Commentary</u>
Record this element for all assembly joints without seals. This element defines only those assembly joints that are open and not sealed. These joints include finger and sliding plate joints.  The total quantity for expansion joints is the sum of all the lengths of each joint.	

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Debris Impaction	No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint.	Partially filled with hard-packed material, but still allowing free movement.	Completely filled and impacts joint movement.	Completely filled and prevents joint movement.
Adjacent Deck or Header	Sound. No spall, delamination or unsound patch.	Edge delamination or spall 1 in. or less or 6 in. or less in diameter. No exposed rebar. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall, delamination, unsound patched area or loose joint anchor that prevents the joint from functioning as intended.
Metal Deterioration or Damage	None	Freckled rust, metal has no cracks, or impact damage. Connections may be loose but functioning as intended.	Section loss, missing or broken fasteners, cracking of the metal or impact damage but joint is still functioning.	Metal cracking, section loss, damage or connection failure that prevents the joint from functioning as intended.

<b>Gasket</b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1610
<u>Specification</u>	<u>Commentary</u>
Record this element for all gaskets. This element defines those gaskets which are joints between segmental tunnel liners and can be made of lead, mastic, or rubber.  The total quantity for gasket is the sum of all lengths of each gasket.	

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Leakage	None	Minimal. Minor dripping through joints.	Moderate. More than a drip and less than free flow of water.	Free flow of water through the joint.
Seal Adhesion	Fully adhered.	Adhered for more than 50% of the joint height.	Adhered 50% or less of joint height but still some adhesion.	Complete loss of adhesion.
Seal Damage	None	Seal abrasion without punctures.	Punctured or ripped or partially pulled out.	Punctured completely through, pulled out, or missing.
Seal Cracking	None	Surface crack.	Crack that partially penetrates the seal.	Crack that fully penetrates the seal.
Debris Impaction	No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint.	Partially filled with hard-packed material, but still allowing free movement.	Completely filled and impacts joint movement.	Completely filled and prevents joint movement.
Adjacent Deck or Header	Sound. No spall, delamination or unsound patch.	Edge delamination or spall 1 in. or less or 6 in. or less in diameter. No exposed rebar. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall, delamination, unsound patched area or loose joint anchor that prevents the joint from functioning as intended.

Condition State Definitions Cont.				
Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Metal Deterioration or Damage	None	Freckled rust, metal has no cracks, or impact damage. Connections may be loose but functioning as intended.	Section loss, missing or broken fasteners, cracking of the metal or impact damage but joint is still functioning.	Metal cracking, section loss, damage or connection failure that prevents the joint from functioning as intended.

## 3.3—Civil Section

## Civil Section

This section defines tunnel civil elements and the methodology for determining total element quantities and condition state quantities. The following elements are included.

Element #	Element Name	Unit of Measure
	Wearing Surface	
1800	Concrete Wearing Surface	AREA (Feet <sup>2</sup> )
1801	Asphalt Wearing Surface	AREA (Feet <sup>2</sup> )
1802	Other Wearing Surface	AREA (Feet <sup>2</sup> )
	Traffic Barrier	
1850	Concrete Traffic Barrier	LENGTH (Feet)
1851	Steel Traffic Barrier	LENGTH (Feet)
1852	Other Traffic Barrier	LENGTH (Feet)
	Pedestrian Railing	
1900	Concrete Pedestrian Railing	LENGTH (Feet)
1901	Steel Pedestrian Railing	LENGTH (Feet)
1902	Other Pedestrian Railing	LENGTH (Feet)

<b>Concrete Wearing Surface</b>	
<u>Unit of Measure</u> Area (Feet <sup>2</sup> )	<u>Element Number</u> 1800
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all concrete wearing surfaces. This element defines the tunnel roadway surface that carries the. The wearing surface is sacrificial and helps protect the structural slab from wear and damage.</p> <p>The total area of the wearing surface is the product of the width and length of the surface.</p>	<p>Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</p>

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Delamination/ Spall/ Patched area/pothole	None	Delaminated. Spall less than 1 in. deep or less than 6 in. diameter. Patched area that is sound. Partial depth pothole.	Spalls 1 in. deep or greater or 6 in. diameter or greater. Patched area that is unsound or showing distress. Full depth pothole.	The wearing surface is no longer effective.
Crack	Width less than 0.012 in. or spacing greater than 3.0 ft.	Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft.	Width greater than 0.05 in. or spacing of less than 1.0 ft.	
Effectiveness	Fully effective. No evidence of leakage or further deterioration of the protected element.	Substantially effective. Deterioration of the protected element has slowed.	Limited effectiveness. Deterioration of the protected element has progressed.	

<b><i>Asphalt Wearing Surface</i></b>	
<u>Unit of Measure</u> Area (Feet <sup>2</sup> )	<u>Element Number</u> 1801
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all asphalt wearing surfaces. This element defines the tunnel roadway surface that carries the vehicles. The wearing surface is sacrificial and helps protect the structural slab from wear and damage.</p> <p>The total area of the wearing surface is the product of the width and length of the surface.</p>	Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
General Condition	Good condition – no notable distress	Fair condition- isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	The wearing surface is no longer effective.
Effectiveness	Fully effective. No evidence of leakage or further deterioration of the protected element.	Substantially effective. Deterioration of the protected element has slowed.	Limited effectiveness. Deterioration of the protected element has progressed.	

<b>Other Wearing Surface</b>	
<u>Unit of Measure</u> Area (Feet <sup>2</sup> )	<u>Element Number</u> 1802
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all wearing surfaces composed of other materials. This element defines the tunnel roadway surface that carries the vehicles. The wearing surface is sacrificial and helps protect the structural slab from wear and damage.</p> <p>The total area of the wearing surface is the product of the width and length of the surface.</p>	Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
General Condition	Good condition – no notable distress	Fair condition- isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	The wearing surface is no longer effective.
Effectiveness	Fully effective. No evidence of leakage or further deterioration of the protected element.	Substantially effective. Deterioration of the protected element has slowed.	Limited effectiveness. Deterioration of the protected element has progressed.	

<b>Concrete Traffic Barrier</b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1850
<u>Specification</u>	<u>Commentary</u>
Record this element for all concrete traffic barriers. This element defines those tunnel barriers adjacent to a roadway. All elements of the barrier must be concrete.  The total quantity for traffic barrier is the sum of all the lengths of each traffic barrier.	Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Delamination/ Spall/ Patched area	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Exposed Rebar	None	Present without measureable section loss.	Present with measureable section loss, but does not warrant structural review.	
Efflorescence/ Rust Staining	None	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking	Width less than 0.012 in. or spacing greater than 3.0 ft.	Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft.	Width greater than 0.05 in. or spacing less than 1 ft.	

<b>Steel Traffic Barrier</b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1851
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all steel traffic barriers. This element defines those tunnel barriers adjacent to a roadway. Horizontal members must be steel, however, posts may be made of steel, timber, concrete or other materials.</p> <p>The total quantity for traffic barrier is the sum of all the lengths of each traffic barrier.</p>	<p>Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.</p>

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Corrosion	None	Freckled rust. Corrosion of steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Cracking	None	Crack that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack exists that is not arrested but does not warrant a structural review.	
Connections	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant a structural review.	
Distortion	None	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	

<b><i>Other Traffic Barrier</i></b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1852
<u>Specification</u>	<u>Commentary</u>
Record this element for all traffic barriers composed of other materials. This element defines those tunnel barriers adjacent to a roadway.  The total quantity for traffic barrier is the sum of all the lengths of each traffic barrier.	Visual assessments may be supplemented with non-destructive or destructive testing results for all elements.

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
General Condition	Good condition – no notable distress	Fair condition- isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.

<b>Concrete Pedestrian Railing</b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1900
<u>Specification</u>	<u>Commentary</u>
Record this element for all concrete pedestrian railing. This element defines those tunnel railings adjacent to a walkway.  The total quantity for pedestrian railing is the sum of all the lengths of each pedestrian railing.	

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Delamination/ Spall/ Patched area	None	Delaminated. Spall 1 in. or less deep or 6 in. or less diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Exposed Rebar	None	Present without measureable section loss.	Present with measureable section loss, but does not warrant structural review.	
Efflorescence/ Rust Staining	None	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking	Width less than 0.012 in. or spacing greater than 3.0 ft.	Width 0.012 - 0.05 in. or spacing of 1.0 – 3.0 ft.	Width greater than 0.05 in. or spacing less than 1 ft.	
Out-of-Plumb	None	Minor tilt which is barely noticeable.	Excessive tilt that affects operations or near failure.	

<b><i>Steel Pedestrian Railing</i></b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1901
<u>Specification</u>	<u>Commentary</u>
Record this element for all steel pedestrian railing. This element defines those tunnel railings adjacent to a walkway.  The total quantity for pedestrian railing is the sum of all the lengths of each pedestrian railing.	

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Corrosion	None	Freckled rust. Corrosion of steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Cracking	None	Crack that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack exists that is not arrested but does not warrant a structural review.	
Connections	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, broken welds, fasteners or pack rust with distortion but does not warrant a structural review.	
Distortion	None	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Out-of-Plumb	None	Minor tilt which is barely noticeable.	Excessive tilt that affects operations or near failure.	

<b><i>Other Pedestrian Railing</i></b>	
<u>Unit of Measure</u> Length (Feet)	<u>Element Number</u> 1902
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all pedestrian railing composed of other materials. This element defines those tunnel railings adjacent to a walkway.</p> <p>The total quantity for pedestrian railing is the sum of all the lengths of each pedestrian railing.</p>	

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
General Condition	Good condition – no notable distress	Fair condition- isolated breakdowns or deterioration.	Poor condition – widespread deterioration or breakdowns without reducing load capacity.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or tunnel, OR a structural review has been completed and the defects impact strength and serviceability of the element or tunnel.
Out-of-Plumb	None	Minor tilt which is barely noticeable.	Excessive tilt that affects operations or near failure.	

### 3.4—Mechanical Systems Section

## Mechanical Systems Section

This section defines tunnel mechanical system elements and the methodology for determining total element quantities and condition state quantities. The following elements are included.

Element #	Element Name	Unit of Measure
	Ventilation System	
2000	Ventilation System	EACH
2001	Fans	EACH
	Drainage System	
2050	Draining and Pumping System	EACH
2051	Pumps	EACH
	Emergency Generator System	
2100	Emergency Generator System	EACH
	Flood Gate	
2150	Flood Gate	EACH

<b><i>Ventilation System</i></b>	
<u>Unit of Measure</u> Each	<u>Element Number</u> 2000
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all ventilation systems. This element describes the components that provide the supply of fresh air to the tunnel while removing stale air and contaminants.</p> <p>The total quantity for ventilation system is the sum of all the ventilation systems.</p>	<p>The ventilation system may include the following subcomponents: Fans - Fan Motors, Fan Controller, Airways, Sound Attenuators, Dampers, Damper Motor, Damper Controller, Air Quality Monitoring Equipment (CO), Control Panels and Conduit.</p> <p>Damper inspection should also include a review of the maintenance records for each piece of equipment and note any special or frequent maintenance problems.</p> <p>For this element, a separate ventilation system is considered to be one system. Tunnels with twin bores may have separate ventilation systems and would be considered as two. Some tunnels may have a ventilation system at each portal that work independently and would also be considered as two.</p>

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
System Operations	The system operates at capacity.	The system operates at a capacity of not less than 95%.	The system operates at a capacity less than 95%, but has not fallen below the minimum safe capacity.	The system does not operate at the minimum safe capacity.

<b><i>Fans</i></b>	
<u>Unit of Measure</u> Each	<u>Element Number</u> 2001
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all fans. This element describes the components that produce a current of air which provides the supply of fresh air to the tunnel while removing stale air and contaminants.</p> <p>The total quantity for fans is the sum of all the fans.</p>	<p>The fans may include the following subcomponents: Fan Motors, Fan Controller, etc.</p>

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Fan Operation (includes fan belt, fan chain, fan bearing temperature and/or fan drive temperature)	Operates on all speeds and in all modes with no noticeable temperature rise.	Operates on all speeds and in all modes. Requires manual restart or manual control to achieve this. Drive(s) require some adjustment. More than normal play observed. (If belt – minor wear/deterioration to belt.) Less than 40 degree F temperature rise form ambient temperatures during operation.	Fan operates on at least one speed or only operates in manual mode. Drive(s) require major adjustment. Severe play and/or belt/chain noise is observed. (If belt – moderate wear/deterioration to belt.) Between 40 degree F and 80 degree F temperature rise form ambient temperatures during operation.	Fan will not operate on any speed. Over 80 degree F temperature rise form ambient temperatures during operation.

<b><i>Draining and Pumping System</i></b>	
<u>Unit of Measure</u> Each	<u>Element Number</u> 2050
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all draining and pumping systems. This element includes storm drains, piping, pumps and water treatment equipment for the removal of water that may enter the tunnel from the portals, vent shafts, and cracks in the tunnel lining. Drainage at the tunnel facility also handles the drippings from vehicles traversing the tunnel and potential spills from trucks hauling liquid materials.</p> <p>The total quantity for draining and pumping system is the sum of all the draining and pumping systems.</p>	<p>The drainage and pumping system may include the following subcomponents: Pumps – Sump Pumps, Pump Motors, Pump Controller, Piping, Drains and Water Treatment Equipment.</p> <p>For this element, a separate draining and pumping system is considered to be one system. Tunnels with twin bores may have separate draining and pumping systems and would be considered as two. Some tunnels may have a draining and pumping system at each portal that work independently and would also be considered as two.</p>

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
System Operations	The system operates at capacity.	The system operates at a capacity of not less than 95%.	The system operates at a capacity less than 95%, but has not fallen below the minimum safe capacity.	The system does not operate at the minimum safe capacity.

<b><i>Pumps</i></b>	
<u>Unit of Measure</u> Each	<u>Element Number</u> 2051
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all pumps. This element includes the component that moves water that may enter the tunnel from the portals, vent shafts, and crack in the tunnel lining.</p> <p>The total quantity for pumps is the sum of all the pumps.</p>	<p>The pumps may include the following subcomponents: Sump Pumps, Pump Motors, Pump Controller, etc.</p>

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Pump Operation (Includes Sump Pump, Pump Motor, Pump Controller, Pump Control Panel, Oil Leakage, Pump Leakage, Noise and Vibration and Temperature)	Operates at all speeds and in all modes. Shut-off valves operate freely and without binding. Fair amount of noise and vibration velocity of 100 in./s or less. No oil leakage observed. No leakage observed at pump seal. No water leakage noted in immediate piping and valves. Motor temperature is within expected limits.	Operates at all speeds and in all modes in a reduced capacity. Shut-off valves operate with some resistance and binding but do appear to fully open/seal. Slightly rough noise and vibration velocity between 100 and 300 in./s. Limited exterior staining from oil seepage at seals. Limited exterior water seepage from seals with seals appearing wet. Motor temperature is slightly increased during motor operation.	Operates intermittently or haltingly. Shut-off valves difficult or impossible to operate. Rough noise and vibration velocity in excess of 300 in./s. Extensive exterior staining from oil seepage around seals. Measurable water seepage around seals that can be quantified in drips per minute. Motor temperature is moderately above what is expected and/or hot spots of temperature exist.	Pump will not operate. Pooling of oil on exterior surfaces of seals or significant reduction of interior lubricant level. A visible stream of water on exterior surfaces of seals or significant reduction of pump performance. Motor temperature is drastically increased and motor function is influenced.

<b><i>Emergency Generator System</i></b>	
<u>Unit of Measure</u> Each	<u>Element Number</u> 2100
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all emergency generator systems. These elements are the mechanical components of an emergency generator and power system which consist of fuel delivery, fuel storage, an engine cooling and exhaust systems. The emergency generator provides a back-up power source in the event of utility service failure to the tunnel. The mechanical systems support the proper operation of the generator to provide back-up power.</p> <p>The total quantity for emergency generator is the sum of all the emergency generator systems.</p>	<p>The emergency generator system may include the following subcomponents: Fuel Main Storage Tank, Fuel Day Tanks, Circulating Fuel Pumps, Fuel Tank Venting, Fuel Tank Sensors, Coolant Systems, Exhaust Manifold Insulation and Lagging, Exhaust Air Louver and Damper Actuator, Supply Air Louver and Damper Actuator, Generator, Generator Control Equipment, Control Panels and Conduit.</p> <p>For this element, a separate emergency generator system is considered to be one system. Tunnels with twin bores may have separate emergency generator systems and would be considered as two.</p>

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
System Operations	The system operates at capacity.	The system operates at a capacity of not less than 95%.	The system operates at a capacity less than 95%, but has not fallen below the minimum safe capacity.	The system does not operate at the minimum safe capacity.

<b><i>Flood Gate</i></b>	
<u>Unit of Measure</u> Each	<u>Element Number</u> 2150
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all flood gates. These elements are the actual gates, seals, mechanical components, and power supply of a flood gate system. The flood gates are typically located at each portal for each bore. The flood gates are usually used when the tunnel roadway is closed and the bores are threatened with taking on water at the portals.</p> <p>The total quantity for flood gate is the sum of all the flood gates.</p>	<p>For this element, a separate flood gate is considered to be one gate. Some tunnels may have a flood gate at each portal that work independently and would be considered as two.</p>

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
System Operations	The system operates at capacity.	The system operates at a capacity of not less than 95%.	The system operates at a capacity less than 95%, but has not fallen below the minimum safe capacity.	The system does not operate at the minimum safe capacity.

### 3.5—Electrical Systems Section

## Electrical Systems Section

This section defines tunnel electrical systems elements and the methodology for determining total element quantities and condition state quantities. The following elements are included.

Element #	Element Name	Unit of Measure
	Electrical Distribution	
2200	Electrical Distribution System	EACH
	Emergency Distribution	
2250	Emergency Distribution System	EACH

<b><i>Electrical Distribution System</i></b>	
<u>Unit of Measure</u> Each	<u>Element Number</u> 2200
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all electrical distribution systems. The electrical distribution system consists of the electrical equipment, wiring, conduit, and cable used for distributing electrical energy from the utility supply (service entrance) to the line terminals of utilization equipment.</p> <p>The total quantity for electrical distribution system is the sum of all the electrical distribution systems.</p>	<p>The electrical distribution system may include the following subcomponents: Switchgear, Unit Substations, Switchboard, Motor Control Centers, Starters, Transformers, Transfer Switches, Panelboards, Conduits and Raceways, and Electrical Outlets/Receptacles.</p> <p>For this element, a separate electrical distribution system is considered to be one system. Tunnels with twin bores may have separate electrical distribution systems and would be considered as two.</p>

<u>Condition State Definitions</u>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
System Operations	The system operates at capacity.	The system operates at a capacity of not less than 95%.	The system operates at a capacity less than 95%, but has not fallen below the minimum safe capacity.	The system does not operate at the minimum safe capacity.

<b><i>Emergency Distribution System</i></b>	
<u>Unit of Measure</u> Each	<u>Element Number</u> 2250
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all emergency distribution systems. This system consists of the electrical equipment, wiring, conduit, and cable used for providing electrical power in case of utility service failure. Equipment included in this system consists of emergency generators and/or uninterruptible power supply (UPS) systems, transfer switches, and other equipment supplying emergency power.</p> <p>The total quantity for emergency distribution system is the sum of all the emergency distribution systems.</p>	<p>The emergency distribution system may include the following subcomponents: Uninterruptible Power Supply (UPS), batteries and battery charging equipment.</p> <p>For this element, a separate emergency distribution system is considered to be one system. Tunnels with twin bores may have separate emergency distribution systems and would be considered as two.</p>

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
System Operations	The system operates at capacity.	The system operates at a capacity of not less than 95%.	The system operates at a capacity less than 95%, but has not fallen below the minimum safe capacity.	The system does not operate at the minimum safe capacity.

## 3.6—Lighting Systems Section

## Lighting Systems Section

This section defines tunnel lighting systems elements and the methodology for determining total element quantities and condition state quantities. The following elements are included.

Element #	Element Name	Unit of Measure
	Tunnel Lighting	
2300	Tunnel Lighting Systems	EACH
2301	Tunnel Lighting Fixtures	EACH
	Emergency Lighting	
2350	Emergency Lighting Systems	EACH
2351	Emergency Lighting Fixtures	EACH

<b><i>Tunnel Lighting System</i></b>	
<u>Unit of Measure</u> Each	<u>Element Number</u> 2300
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all tunnel lighting systems. These systems consist of the light fixtures, supports, bulb housings, lenses, light switches, junction boxes, wiring, conduit, cable, sensors, and controllers used to provide lighting for the tunnel.</p> <p>The total quantity for tunnel lighting system is the sum of all the tunnel lighting systems.</p>	<p>The tunnel lighting system may also include the following subcomponents: photo controls, and remote ballasts.</p> <p>For this element, a separate tunnel lighting system is considered to be one system. Tunnels with twin bores may have separate tunnel lighting systems and would be considered as two.</p>

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
System Operations	The system operates at capacity.	The system operates at a capacity of not less than 95%.	The system operates at a capacity less than 95%, but has not fallen below the minimum safe capacity.	The system does not operate at the minimum safe capacity.

<b><i>Tunnel Lighting Fixture</i></b>	
<u>Unit of Measure</u> Each	<u>Element Number</u> 2301
<u>Specification</u>	<u>Commentary</u>
Record this element for all tunnel lighting fixtures. This element includes the physical housing of the tunnel lights and their connections to the tunnel.  The total quantity for tunnel lighting fixture is the sum of all the tunnel lighting fixtures.	

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Component Supports	No deficient support conditions.	Minor section loss of mounting hardware.	Moderate deterioration of supports, or limited local failure of supports.	Failed sections or supports.
Component Paint and Corrosion	Free from rust and corrosion.	80% or more is clean, painted, and free from corrosion.	50% to 80% is clean, painted, and free from corrosion.	50% or less is clean, painted, and free from corrosion.
Component Housing or Enclosure	No damages.	Slight damage or cracks to enclosure.	Moderate damage or cracks to enclosure.	Significant damage, cracks, or holes to enclosure.

<b><i>Emergency Lighting System</i></b>	
<u>Unit of Measure</u> Each	<u>Element Number</u> 2350
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all emergency lighting systems. These systems consist of the light fixtures, supports, bulb housings, lenses, light switches, junction boxes, wiring, conduit, cable, sensors, and controllers used to provide emergency lighting for the facility</p> <p>The total quantity for emergency lighting system is the sum of all the emergency lighting systems.</p>	<p>The emergency lighting system may also include the following subcomponents: exit signs, batteries; and support space sighting, and remote ballasts.</p> <p>For this element, a separate emergency lighting system is considered to be one system. Tunnels with twin bores may have separate emergency lighting systems and would be considered as two.</p>

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
System Operations	The system operates at capacity.	The system operates at a capacity of not less than 95%.	The system operates at a capacity less than 95%, but has not fallen below the minimum safe capacity.	The system does not operate at the minimum safe capacity.

<b><i>Emergency Lighting Fixture</i></b>	
<u>Unit of Measure</u> Each	<u>Element Number</u> 2351
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all emergency lighting fixtures. This element includes the physical housing of the emergency lights and their connections to the tunnel.</p> <p>The total quantity for emergency lighting fixture is the sum of all the emergency lighting fixtures.</p>	

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Component Supports	No deficient support conditions.	Minor section loss of mounting hardware.	Moderate deterioration of supports, or limited local failure of supports.	Failed sections or supports.
Component Paint and Corrosion	Free from rust and corrosion.	80% or more is clean, painted, and free from corrosion.	50% to 80% is clean, painted, and free from corrosion.	50% or less is clean, painted, and free from corrosion.
Component Housing or Enclosure	No damages.	Slight damage or cracks to enclosure.	Moderate damage or cracks to enclosure.	Significant damage, cracks, or holes to enclosure.

### 3.7—Fire/Life Safety/Security Systems Section

## Fire/Life Safety/Security Systems Section

This section defines tunnel fire/life safety/security systems elements and the methodology for determining total element quantities and condition state quantities. The following elements are included.

Element #	Element Name	Unit of Measure
	Fire Detection	
2400	Fire Detection System	EACH
	Fire Protection	
2450	Fire Protection System	EACH
	Emergency Communications	
2500	Emergency Communications System	EACH
	Operations and Security	
2550	Tunnel Operations and Security System	EACH

<b><i>Fire Detection System</i></b>	
<u>Unit of Measure</u> Each	<u>Element Number</u> 2400
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all fire detection systems. These systems consist of control panels, initiating devices (heat and smoke detectors, pull-stations, etc.), notification appliances (strobes, horns, etc.), wiring, conduit, and cable used to detect a fire in the tunnel.</p> <p>The total quantity for fire detection system is the sum of all the fire detection systems.</p>	<p>The fire detection system may also include the following subcomponents: sensors, controls, and alarms.</p> <p>For this element, a separate fire detection system is considered to be one system. Tunnels with twin bores may have separate fire detection systems and would be considered as two.</p>

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
System Operations	The system operates at capacity.	The system operates at a capacity of not less than 95%.	The system operates at a capacity less than 95%, but has not fallen below the minimum safe capacity.	The system does not operate at the minimum safe capacity.
Detection Sensor Operations (heat and smoke detectors)	All detection sensors are operational.		Detection sensors are not operational in one zone.	Detection sensors are not operational in multiple zones.

<b>Fire Protection System</b>	
<u>Unit of Measure</u> Each	<u>Element Number</u> 2450
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all fire protection systems. These systems consist of fire extinguishers, hose connections, storage tanks, fire hydrants, building sprinklers, pumping systems, piping, circulating pumps, and hose reels used as fire protection in the tunnel.</p> <p>The total quantity for fire protection system is the sum of all the fire protection systems.</p>	<p>The fire protection system may include the following subcomponents: main fire pump, pressure maintenance/jockey pump, dry pipe valve, valves and tamper switches, storage tanks, tunnel stand pipe, pressure relief and air release valves, backflow prevention, hose stations, hose reels, building sprinklers, fire department connections and fire hydrants.</p> <p>For this element, a separate fire protection system is considered to be one system. Tunnels with twin bores may have separate fire protection systems and would be considered as two.</p>

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
System Operations	The system operates at capacity.	The system operates at a capacity of not less than 95%.	The system operates at a capacity less than 95%, but has not fallen below the minimum safe capacity.	The system does not operate at the minimum safe capacity.

<b><i>Emergency Communication System</i></b>	
<u>Unit of Measure</u> Each	<u>Element Number</u> 2500
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all emergency communication systems. The components of the emergency communication system include the communication device itself (i.e. intercom, radios, cell-phone), receivers, wiring, exchange devices, etc.</p> <p>The total quantity for emergency communication system is the sum of all the emergency communication systems.</p>	<p>The emergency communications system may also include the following subcomponents: signs, controllers, speakers and audio input equipment.</p> <p>For this element, a separate emergency communication system is considered to be one system. Tunnels with twin bores may have separate emergency communication systems and would be considered as two.</p>

<u>Condition State Definitions</u>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
System Operations	The system operates at capacity.	The system operates at a capacity of not less than 95%.	The system operates at a capacity less than 95%, but has not fallen below the minimum safe capacity.	The system does not operate at the minimum safe capacity.

<b><i>Tunnel Operations and Security System</i></b>	
<u>Unit of Measure</u> Each	<u>Element Number</u> 2550
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all tunnel operations and security systems. These systems consist of the communication equipment (CCTV cameras, telephones, radios, etc.) used to provide communication within and from the tunnel.</p> <p>The total quantity for tunnel operations and security system is the sum of all the tunnel operations and security systems.</p>	<p>The tunnel operations and security system may also include the following subcomponents: closed-circuit camera system, cell phone antennas, door access, controller and radio.</p> <p>For this element, a separate tunnel operation and security system is considered to be one system. Tunnels with twin bores may have separate tunnel operations and security systems and would be considered as two.</p>

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
System Operations	The system operates at capacity.	The system operates at a capacity of not less than 95%.	The system operates at a capacity less than 95%, but has not fallen below the minimum safe capacity.	The system does not operate at the minimum safe capacity.

## 3.8—Signs Section

## Signs Section

This section defines tunnel sign elements and the methodology for determining total element quantities and condition state quantities. The following elements are included.

Element #	Element Name	Unit of Measure
	Traffic Guidance	
2600	Traffic Sign	EACH
	Pedestrian	
2625	Pedestrian Sign	EACH
	Variable Message Boards	
2650	Variable Message Board	EACH
	Lane Signal	
2675	Lane Signal	EACH
2676	Lane Signal Fixture	EACH

<b><i>Traffic Sign</i></b>	
<u>Unit of Measure</u> Each	<u>Element Number</u> 2600
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all traffic signs. These elements consist of the traffic sign and supports. Signs for pedestrians, variable message signs and lane signals are not covered under this element.</p> <p>The total quantity for traffic signs is the sum of all the traffic signs.</p>	<p>The MUTCD Chapter 2 contains the requirements for the shape and wording of regulatory, warning and guide signs on a highway or road. It also contains requirements for maintaining minimum retroreflectivity of signs.</p>

<u>Condition State Definitions</u>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Support condition	No deficient support conditions.	Minor loss of mounting hardware.	Moderate deterioration of supports, or limited local failure of supports.	Failed sections of supports.

<b><i>Pedestrian Sign</i></b>	
<u>Unit of Measure</u> Each	<u>Element Number</u> 2625
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all pedestrian signs. This element consists of pedestrian signs and their supports that are not related to the emergency lighting system.</p> <p>The total quantity for pedestrian sign is the sum of all the pedestrian signs.</p>	<p>The MUTCD Chapter 2 contains the requirements for the shape and wording of regulatory, warning and guide signs on a highway or road. It also contains requirements for maintaining minimum retroreflectivity of signs.</p>

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Support condition	No deficient support conditions.	Minor loss of mounting hardware.	Moderate deterioration of supports, or limited local failure of supports.	Failed sections of supports.

<b>Variable Message Board</b>	
<u>Unit of Measure</u> Each	<u>Element Number</u> 2650
<u>Specification</u>	<u>Commentary</u>
Record this element for all variable message boards. This element consists of the variable message board, supports and associated electrical connections.  The total quantity for variable message board is the sum of all the variable message boards.	The MUTCD Chapter 2 contains the requirements for the shape and wording of regulatory, warning and guide signs on a highway or road. It also contains requirements for maintaining minimum retroreflectivity of signs.

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Support condition	No deficient support conditions.	Minor loss of mounting hardware.	Moderate deterioration of supports, or limited local failure of supports.	Failed sections of supports.
Sign Operation	Sign is functional and operates when tested.	Sign operates with minor decrease in light output, flicker, or reduced display area.	Sign operates with significant decrease in light output, flicker, and/or reduced display area.	Sign is not operational.

<b><i>Lane Signal</i></b>	
<u>Unit of Measure</u> Each	<u>Element Number</u> 2675
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all lane signals. The components of the tunnel lane signal system include the lane signals themselves, their supports and the control system.</p> <p>The total quantity for lane signal is the sum of all the lane signals.</p>	<p>The lane signals may include the following subcomponents: signals/fixtures, control station, control cabinets and conduit.</p> <p>The MUTCD Chapter 2 contains the requirements for the shape and wording of regulatory, warning and guide signs on a highway or road. It also contains requirements for maintaining minimum retroreflectivity of signs.</p>

<u>Condition State Definitions</u>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Support condition	No deficient support conditions.	Minor loss of mounting hardware.	Moderate deterioration of supports, or limited local failure of supports.	Failed sections of supports.
Sign Operation	Sign is functional and operates when tested.	Sign operates with minor decrease in light output, flicker, or reduced display area.	Sign operates with significant decrease in light output, flicker, and/or reduced display area.	Sign is not operational.

<b><i>Lane Signal Fixture</i></b>	
<u>Unit of Measure</u> Each	<u>Element Number</u> 2676
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all lane signal fixtures. The components of the tunnel lane signal fixtures include the fixtures themselves, the supports and the wiring.</p> <p>The total quantity for lane signal fixture is the sum of all the lane signal fixtures.</p>	<p>The lane signal fixtures may also include the following subcomponents: fixtures and conduit.</p> <p>The MUTCD Chapter 2 contains the requirements for the shape and wording of regulatory, warning and guide signs on a highway or road. It also contains requirements for maintaining minimum retroreflectivity of signs.</p>

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Component Supports	No deficient support conditions.	Minor loss of mounting hardware.	Moderate deterioration of supports, or limited local failure of supports.	Failed sections or supports.
Component Paint and Corrosion	Free from rust and corrosion.	80% or more is clean, painted, and free from corrosion.	50% to 80% is clean, painted, and free from corrosion.	50% or less is clean, painted, and free from corrosion.
Component Housing or Enclosure	No damages.	Slight damage or cracks to enclosure.	Moderate damage or cracks to enclosure.	Significant damage, cracks, or holes to enclosure.

### 3.9—Protective Systems Section

## Protective Systems Section

This section defines tunnel protective system elements and the methodology for determining total element quantities and condition state quantities. The following elements are included.

Element #	Element Name	Unit of Measure
	Protective Coating	
2700	Steel Corrosion Protective Coating	AREA (Feet <sup>2</sup> )
2710	Concrete Corrosion Protective Coating	AREA (Feet <sup>2</sup> )
2750	Fire Protective Coating	AREA (Feet <sup>2</sup> )

<b>Steel Corrosion Protective Coating</b>	
<u>Unit of Measure</u> Area (Feet <sup>2</sup> )	<u>Element Number</u> 2700
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all steel corrosion protective coating used in the tunnel. The element is for steel elements that have a protective coating system such as paint, galvanization, or other top coat steel corrosion inhibitor.</p> <p>The total quantity for protective coatings is the product of the length and width of the entire exposed surface of the element.</p>	<p>Effectiveness is an evaluation made by the inspector to classify the degree to which the protection system is functioning to protect the steel beneath.</p>

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Chalking	None	Surface dulling.	Loss of pigment.	Not applicable.
Peeling/Bubbling/Cracking	None	Finish coats only.	Finish and primer coats.	Exposure of bare metal.
Oxide Film Degradation Color/Texture Adherence	Yellow-orange or light brown for early development. Chocolate-brown to purple-brown for fully developed. Tightly adhered, capable of withstanding hammering or vigorous wire brushing.	Granular texture.	Small flakes, less than ½ in. diameter.	Dark black color. Large flakes, ½ in. diameter or greater; or laminar sheets or nodules.
Effectiveness	Fully effective.	Substantially effective.	Limited effectiveness.	Failed, no protection of the underlying metal.

<b>Concrete Corrosion Protective Coating</b>	
<u>Unit of Measure</u> Area (Feet <sup>2</sup> )	<u>Element Number</u> 2710
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all concrete corrosion protective coating used in the tunnel. This element is for concrete elements that have a protective coating applied to them. These coatings include silane/siloxane water proofers, crack sealers such as High Molecular Weight Methacrylate (HMWM), or any top coat barrier that protects concrete from deterioration and reinforcing steel from corrosion.</p> <p>The total quantity for protective coatings is the product of the length and width of the entire exposed surface of the element.</p>	<p>Effectiveness is an evaluation made by the inspector to classify the degree to which the protection system is functioning.</p>

<b>Condition State Definitions</b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Wear	None	Underlying concrete not exposed, coating is showing wear from UV exposure, friction course missing.	Underlying concrete is not exposed; thickness of the coating is reduced.	Underlying concrete is exposed. Protective coating is no longer effective.
Effectiveness	Fully effective	Substantially effective.	Limited effectiveness.	Failed – no protection of underlying concrete.

<b><i>Fire Protective Coating</i></b>	
<u>Unit of Measure</u> Area (Feet <sup>2</sup> )	<u>Element Number</u> 2750
<u>Specification</u>	<u>Commentary</u>
<p>Record this element for all fire protective coatings used in the tunnel. This element is the coating applied on the tunnel elements to protect these elements from fire.</p> <p>The total quantity for protective coatings is the product of the length and width of the entire exposed surface of the element.</p>	Fire protection includes fireproofing spray, etc.

<b><u>Condition State Definitions</u></b>				
<b>Defect</b>	<b>Condition State 1</b>	<b>Condition State 2</b>	<b>Condition State 3</b>	<b>Condition State 4</b>
Effectiveness	Fully effective	Substantially effective.	Limited effectiveness.	Failed – no protection of underlying concrete.

# Index of Inventory Items and Elements

## Inventory Items

### 2.2—Identification Items

- I.1 Tunnel Number
- I.2 Tunnel Name
- I.3 State Code
- I.4 County Code
- I.5 Place Code
- I.6 Highway Agency District
- I.7 Route Number
- I.8 Route Direction
- I.9 Route Type
- I.10 Facility Carried
- I.11 LRS Route ID
- I.12 LRS Mile Point
- I.13 Tunnel Portal's Latitude
- I.14 Tunnel Portal's Longitude
- I.15 Border Tunnel State or Country Code
- I.16 Border Tunnel Financial Responsibility
- I.17 Border Tunnel Number
- I.18 Border Tunnel Inspection Responsibility

### 2.3—Age and Service Items

- A.1 Year Built
- A.2 Year Rehabilitated
- A.3 Total Number of Lanes
- A.4 Average Daily Traffic
- A.5 Average Daily Truck Traffic
- A.6 Year of Average Daily Traffic
- A.7 Detour Length
- A.8 Service in Tunnel

### 2.4—Classification Items

- C.1 Owner
- C.2 Operator
- C.3 Direction of Traffic
- C.4 Toll
- C.5 NHS Designation
- C.6 STRAHNET Designation
- C.7 Functional Classification

### 2.5—Geometric Data Items

- G.1 Tunnel Length

- G.2 Minimum Vertical Clearance over Tunnel Roadway
- G.3 Roadway Width, Curb-to-Curb
- G.4 Left Curb and Right Curb Widths

#### 2.6—Inspection items

- D.1 Routine Inspection Target Date
- D.2 Actual Routine Inspection Date
- D.3 Routine Inspection Interval
- D.4 In-Depth Inspection
- D.5 Damage Inspection
- D.6 Special Inspection

#### 2.7—Load Rating and Posting Items

- L.1 Load Rating Method
- L.2 Rating Factor for AASHTO Type 3 Truck
- L.3 Rating for AASHTO Type 3 Truck
- L.4 Rating Factor for AASHTO Type 3S2 Truck
- L.5 Rating for AASHTO Type 3S2 Truck
- L.6 Rating Factor for AASHTO Type 3-3 Truck
- L.7 Rating for AASHTO Type 3-3 Truck
- L.8 Rating Factor for State Routine Permit Truck
- L.9 Rating for State Routine Permit Truck
- L.10 Tunnel Open, Posted or Closed to Traffic
- L.11 Field Load Posting
- L.12 Traffic Restrictions

#### 2.8—Navigation Items

- N.1 Under Navigable Waterway
- N.2 Navigable Waterway Clearance
- N.3 Tunnel or Portal Island Protection from Navigation

#### 2.9—Structure Type and Material Items

- S.1 Number of Bores
- S.2 Tunnel Shape
- S.3 Portal Shapes
- S.4 Ground Conditions
- S.5 Complex

**Elements**

## 3.2—Structural Section

Element #	Element Name	Unit of Measure
	<b>Liners</b>	
1000	Steel Tunnel Liner	AREA (Feet <sup>2</sup> )
1001	Cast-in-Place Concrete Tunnel Liner	AREA (Feet <sup>2</sup> )
1002	Precast Concrete Tunnel Liner	AREA (Feet <sup>2</sup> )
1003	Shotcrete Tunnel Liner	AREA (Feet <sup>2</sup> )
1004	Timber Tunnel Liner	AREA (Feet <sup>2</sup> )
1005	Masonry Tunnel Liner	AREA (Feet <sup>2</sup> )
1006	Unlined Rock Tunnel	AREA (Feet <sup>2</sup> )
1007	Other Tunnel Liner	AREA (Feet <sup>2</sup> )
	<b>Tunnel Roof Girders</b>	
1050	Steel Tunnel Roof Girders	LENGTH (Feet)
1051	Concrete Tunnel Roof Girders	LENGTH (Feet)
1052	Prestressed Concrete Tunnel Roof Girders	LENGTH (Feet)
1053	Other Tunnel Roof Girders	LENGTH (Feet)
	<b>Columns/Piles</b>	
1100	Steel Columns/Piles	EACH
1101	Concrete Columns/Piles	EACH
1102	Other Columns/Piles	EACH
	<b>Cross Passageway</b>	
1150	Steel Cross Passageway	LENGTH (Feet)
1151	Concrete Cross Passageway	LENGTH (Feet)
1152	Shotcrete Cross Passageway	LENGTH (Feet)
1153	Timber Cross Passageway	LENGTH (Feet)
1154	Masonry Cross Passageway	LENGTH (Feet)
1155	Unlined Rock Cross Passageway	LENGTH (Feet)
	<b>Interior Walls</b>	
1200	Concrete Interior Walls	AREA (Feet <sup>2</sup> )
1201	Other Interior Walls	AREA (Feet <sup>2</sup> )
	<b>Portal</b>	
1250	Concrete Portal	AREA (Feet <sup>2</sup> )
1251	Masonry Portal	AREA (Feet <sup>2</sup> )
1252	Other Portal	AREA (Feet <sup>2</sup> )
	<b>Ceiling Slab</b>	
1300	Concrete Ceiling Slab	AREA (Feet <sup>2</sup> )
1301	Other Ceiling Slab	AREA (Feet <sup>2</sup> )

	Ceiling Girder	
1302	Steel Ceiling Girder	LENGTH (Feet)
1303	Concrete Ceiling Girder	LENGTH (Feet)
1304	Prestressed Concrete Ceiling Girder	LENGTH (Feet)
1305	Other Ceiling Girder	LENGTH (Feet)
	Hangers and Anchorages	
1400	Steel Hangers and Anchorages	EACH
1401	Other Hangers and Anchorages	EACH
	Ceiling Panels	
1410	Steel Ceiling Panels	AREA (Feet <sup>2</sup> )
1411	Concrete Ceiling Panels	AREA (Feet <sup>2</sup> )
1412	Other Ceiling Panels	AREA (Feet <sup>2</sup> )
	Invert Slab	
1500	Concrete Invert Slab	AREA (Feet <sup>2</sup> )
1501	Other Invert Slab	AREA (Feet <sup>2</sup> )
	Slab-on-Grade	
1510	Concrete Slab-on-Grade	AREA (Feet <sup>2</sup> )
1511	Other Slab-on-Grade	AREA (Feet <sup>2</sup> )
	Invert Girder	
1550	Steel Invert Girder	LENGTH (Feet)
1551	Concrete Invert Girder	LENGTH (Feet)
1552	Prestressed Concrete Invert Girder	LENGTH (Feet)
1553	Other Invert Girder	LENGTH (Feet)
	Joints	
1600	Strip Seal Expansion Joint	LENGTH (Feet)
1601	Pourable Joint Seal	LENGTH (Feet)
1602	Compression Joint Seal	LENGTH (Feet)
1603	Assembly Joint With Seal	LENGTH (Feet)
1604	Open Expansion Joint	LENGTH (Feet)
1605	Assembly Joint Without Seal	LENGTH (Feet)
	Gaskets	
1610	Gaskets	LENGTH (Feet)

## 3.3—Civil Section

Element #	Element Name	Unit of Measure
	Wearing Surface	
1800	Concrete Wearing Surface	AREA (Feet <sup>2</sup> )
1801	Asphalt Wearing Surface	AREA (Feet <sup>2</sup> )
1802	Other Wearing Surface	AREA (Feet <sup>2</sup> )
	Traffic Barrier	
1850	Concrete Traffic Barrier	LENGTH (Feet)
1851	Steel Traffic Barrier	LENGTH (Feet)
1852	Other Traffic Barrier	LENGTH (Feet)
	Pedestrian Railing	
1900	Concrete Pedestrian Railing	LENGTH (Feet)
1901	Steel Pedestrian Railing	LENGTH (Feet)
1902	Other Pedestrian Railing	LENGTH (Feet)

## 3.4—Mechanical Systems Section

Element #	Element Name	Unit of Measure
	Ventilation System	
2000	Ventilation System	EACH
2001	Fans	EACH
	Drainage System	
2050	Drainage and Pumping System	EACH
2051	Pumps	EACH
	Emergency Generator System	
2100	Emergency Generator System	EACH
	Flood Gate	
2150	Flood Gate	EACH

## 3.5—Electrical Systems Section

Element #	Element Name	Unit of Measure
	Electrical Distribution	
2200	Electrical Distribution System	EACH
	Emergency Distribution	
2250	Emergency Distribution System	EACH

### 3.6—Lighting Systems Section

Element #	Element Name	Unit of Measure
	Tunnel Lighting	
2300	Tunnel Lighting Systems	EACH
2301	Tunnel Lighting Fixtures	EACH
	Emergency Lighting	
2350	Emergency Lighting Systems	EACH
2351	Emergency Lighting Fixtures	EACH

### 3.7—Fire/Life Safety/Security Systems Section

Element #	Element Name	Unit of Measure
	Fire Detection	
2400	Fire Detection Systems	EACH
	Fire Protection	
2450	Fire Protection Systems	EACH
	Emergency Communications	
2500	Emergency Communications Systems	EACH
	Operations and Security	
2550	Tunnel Operations and Security Systems	EACH

### 3.8—Signs Section

Element #	Element Name	Unit of Measure
	Traffic Guidance	
2600	Traffic Signs	EACH
	Pedestrian	
2625	Pedestrian Signs	EACH
	Variable Message Boards	
2650	Variable Message Boards	EACH
	Lane Signal	
2675	Lane Signals	EACH
2676	Lane Signal Fixture	EACH

### 3.9—Protective Systems Section

Element #	Element Name	Unit of Measure
	Protective Coating	
2700	Steel Corrosion Protective Coating	AREA (Feet <sup>2</sup> )
2710	Concrete Corrosion Protective Coating	AREA (Feet <sup>2</sup> )
2750	Fire Protective Coating	AREA (Feet <sup>2</sup> )

# Appendix A: Tunnel Coding Example

The example provided shows the evaluation and coding of inspection data for tunnels of varying complexity. The example includes the use of Inventory Items and Element Items.

## Arch Cape Tunnel



## Contents

<b>INTRODUCTION .....</b>	<b>182</b>
<b>INVENTORY ITEMS .....</b>	<b>182</b>
IDENTIFICATION .....	182
AGE AND SERVICE .....	183

CLASSIFICATION .....	183
GEOMETRIC DATA .....	183
INSPECTION .....	183
LOAD RATING AND POSTING .....	184
NAVIGATION .....	184
STRUCTURE TYPE AND MATERIAL .....	184
<b>ELEMENT IDENTIFICATION .....</b>	<b>184</b>
<b>ELEMENT QUANTITIES.....</b>	<b>185</b>
<b>ELEMENT CONDITION STATES.....</b>	<b>186</b>
<b>ELEMENT QUANTITY AND CONDITION STATE SUMMARY .....</b>	<b>190</b>

## Introduction

The original Arch Cape Tunnel was constructed in the late 1930s and was timber lined until the late 1990s when a major rehabilitation replaced the timber with a combination of shotcrete and concrete lining. The timber portals were replaced with reinforced concrete structures at the same time. The lighting system and bicycle warning system and signs, and traffic signs were also replaced. At that time, all utilities were removed from their mountings on the tunnel sidewalls and moved to a utility trench in the tunnel concrete invert slab. No major work has been done on the tunnel in the last 12 years.

The 1998 rehabilitation tunnel support and lining system used two completely different systems. The ends of the tunnel received a waterproof membrane with fleece backing and a 2-stage cast-in-place concrete lining to replace the rotted timber sets. Much of the lagging and cordwood was left in place behind the cast-in-place concrete and pressure grouted. The central portion of the tunnel received permanent rock reinforcement and a fiber reinforced shotcrete lining. In this area, except for one localized area described below, all the timber including the lagging and cordwood was removed. With the removal of the lagging and cordwood, some of the surrounding rock mass also fell in. As a result, the rock surface currently covered with shotcrete has some significant overbreak areas. Weep holes were drilled at the wet spots in the shotcrete lining.

## Inventory Items

## Identification

Item ID	Inventory Name	Code
I.1	Tunnel Number	0224700903568
I.2	Tunnel Name	Arch Cape Tunnel
I.3	State Code	41
I.4	County Code	124
I.5	Place Code	43000
I.6	Highway Agency District	05
I.7	Route Number	00101
I.8	Route Direction	0
I.9	Route Type	3

I.10	Facility Carried	US101
I.11	LRS Route ID	000900100S00
I.12	LRS Mile Point	89
I.13	Tunnel Portal's Latitude	45.475886
I.14	Tunnel Portal's Longitude	12.3575887
I.15	Border Tunnel State or Country Code	(blank)
I.16	Border Tunnel Financial Responsibility	(blank)
I.17	Border Tunnel Number	(blank)
I.18	Border Tunnel Inspection Responsibility	(blank)

## Age and Service

Item ID	Inventory Name	Code
A.1	Year Built	1937
A.2	Year Rehabilitated	1998
A.3	Total Number of Lanes	02
A.4	Average Daily Traffic	005000
A.5	Average Daily Truck Traffic	10
A.6	Year of Average Daily Traffic	2010
A.7	Detour Length	028
A.8	Service in Tunnel	3

## Classification

Item ID	Inventory Name	Code
C.1	Owner	01
C.2	Operator	01
C.3	Direction of Traffic	2
C.4	Toll	0
C.5	NHS Designation	1
C.6	STRAHNET Designation	1
C.7	Functional Classification	22

## Geometric Data

Item ID	Inventory Name	Code
G.1	Tunnel Length	1228
G.2	Minimum Vertical Clearance over Tunnel Roadway	14.2
G.3	Roadway Width, Curb-to-Curb	28.0
G.4	Left Curb and Right Curb Widths	035035

## Inspection

Item ID	Inventory Name	Code
D.1	Routine Inspection Target Date	0812
D.2	Actual Routine Inspection Date	0812
D.3	Routine Inspection Interval	24
D.4	In-Depth Inspection	1
D.5	Damage Inspection	0

# Load Rating and Posting

Item ID	Inventory Name	Code
L.1	Load Rating Method	N
L.2	Rating Factor for AASHTO Type 3 Truck	(blank)
L.3	Rating for AASHTO Type 3 Truck	(blank)
L.4	Rating Factor for AASHTO Type 3S2 Truck	(blank)
L.5	Rating for AASHTO Type 3S2 Truck	(blank)
L.6	Rating Factor for AASHTO Type 3-3 Truck	(blank)
L.7	Rating for AASHTO Type 3-3 Truck	(blank)
L.8	Rating Factor for State Routine Permit Truck	(blank)
L.9	Rating for State Routine Permit Truck	(blank)
L.10	Tunnel Open, Posted or Closed to Traffic	A
L.11	Field Load Posting	(blank)
L.12	Traffic Restrictions	000

## Navigation

Item ID	Inventory Name	Code
N.1	Under Navigable Waterway	0
N.2	Navigable Waterway Clearance	00.0
N.3	Tunnel or Portal Island Protection from Navigation	0

# Structure Type and Material

Item ID	Inventory Name	Code
S.1	Number of Bores	1
S.2	Tunnel Shape	2
S.3	Portal Shapes	2
S.4	Ground Conditions	3
S.5	Complex	0

## Element Identification

Based on the review of the as-built plans (not included in this example) and field observations, the following tunnel elements have been identified for reporting to the FHWA.

Element Number	Element Name	Tunnel Description
1000	Cast-in-Place Concrete Tunnel Liner	The tunnel ends have a cast-in-place concrete liner
1003	Shotcrete Tunnel Liner	The tunnel interior has a fiber reinforced shotcrete lining
1250	Concrete Portal	The tunnel has a cast-in-place concrete portal at each end
1510	Concrete Slab-on-Grade	The tunnel has a cast-in-place concrete slab on grade
2300	Tunnel Lighting Systems	The tunnel has a lighting system

2301	Tunnel Lighting Fixtures	The tunnel has light fixtures
2600	Traffic Sign	The tunnels has a traffic sign at each end
2625	Pedestrian Sign	The tunnel has a bicycle sign at each end

## Element Quantities

The following quantities calculations are based on a review of the as-built plans (not included in this example) and verified through field measurements and observations. The total element quantity is calculated by summing the unit of the particular element. The total quantity is recorded for each element.

Element Number	Element Name	Unit of Measure and Specification	Calculation	Quantity
1000	Cast-in-Place Concrete Tunnel Liner	Area (Feet <sup>2</sup> ): <i>The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.</i>	Length = 400 feet Perimeter = 45 feet Area = 400 ft x 45 ft = 18000 ft <sup>2</sup>	18000 Feet <sup>2</sup>
1003	Shotcrete Tunnel Liner	Area (Feet <sup>2</sup> ): <i>The area of a tunnel liner is the product of the length (along the centerline) of the tunnel and the perimeter of the liner.</i>	Length = 1850 feet Perimeter = 45 feet Area = 1850 ft x 45 ft = 83250 ft <sup>2</sup>	83250 Feet <sup>2</sup>
1250	Concrete Portal	Area (Feet <sup>2</sup> ): <i>The area of the portal is the product of the width and height of the portal minus the area of the roadway opening. The area may include wingwalls which retain soil and rock near the portal but does not include walls leading up to the portal.</i>	Portal = 400 ft <sup>2</sup> Wingwalls = 700 ft <sup>2</sup> Area = 400 ft <sup>2</sup> + 700 ft <sup>2</sup> = 1100 ft <sup>2</sup>	1100 Feet <sup>2</sup>
1510	Concrete Slab-on-Grade	Area (Feet <sup>2</sup> ): <i>The area of the slab-on-grade is the product of the width and length of the.</i>	Width = 24 feet Length = 2250 feet Area = 24 ft x 2250 ft = 54000 ft <sup>2</sup>	54000 Feet <sup>2</sup>
2300	Tunnel Lighting Systems	Each: <i>The total quantity for tunnel lighting system is the sum of all the tunnel lighting systems.</i>	1 Tunnel Lighting System	1 Each
2301	Tunnel Lighting Fixtures	Each: <i>The total quantity for tunnel lighting fixture is the sum of all the tunnel lighting fixtures.</i>	560 Tunnel Lighting Fixtures	560 Each

Element Number	Element Name	Unit of Measure and Specification	Calculation	Quantity
2600	Traffic Sign	Each: <i>The total quantity for traffic signs is the sum of all the traffic signs.</i>	2 Traffic Signs	2 Each
2625	Pedestrian Sign	Each: <i>The total quantity for pedestrian sign is the sum of all the pedestrian signs.</i>	2 Pedestrian Signs	2 Each

## Element Condition States

The following condition state codes are based on visual assessments and supplemented with non-destructive or destructive testing as appropriate. The Condition State per unit of the element is assessed for each element. Quantities are assigned to the worst applicable condition state determined over the unit assessed. The quantities are summed and recorded for each condition state.

Element Number	Element Name	Quantity		
1000	Cast-in-Place Concrete Tunnel Liner	18000 Feet²		
Inspection Results				
A visual assessment of the cast-in-place concrete tunnel liner was performed. The inspector identified and documented the location of leakage and cracking in the liner. The inspector identified and documented cracking, distortion, leakage in the tunnel liner. No delaminations, spalls, patched areas, or efflorescence was present in the liner.				
Condition State Defect Assessment				
Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delaminations/ Spalls/ Patched areas	6900 Feet²	0 Feet²	0 Feet²	0 Feet²
Leakage	3000 Feet²	1000 Feet²	0 Feet²	
Distortion	0 Feet²	3000 Feet²	0 Feet²	
Cracking	4000 Feet²	100 Feet²	0 Feet²	
Efflorescence	0 Feet²	0 Feet²	0 Feet²	
Condition State Quantities				
Condition State 1	Condition State 2	Condition State 3	Condition State 4	
13900 Feet²	4100 Feet²	0 Feet²	0 Feet²	

Element Number	Element Name	Quantity
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1003	Shotcrete Tunnel Liner	83250 Feet²		
Inspection Results				
A visual assessment of the shotcrete tunnel liner was performed. The inspector identified and documented the location of leakage and cracking in the liner. No delaminations, spalls, patched areas, distortion, or efflorescence was present in the liner.				
Condition State Defect Assessment				
Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delaminations/ Spalls/ Patched areas	71150 Feet²	0 Feet²	0 Feet²	0 Feet²
Cracking Sizes	2000 Feet²	1000 Feet²	0 Feet²	
Leakage	4000 Feet²	5000 Feet²	100 Feet²	
Distortion	0 Feet²	0 Feet²	0 Feet²	
Efflorescence	0 Feet²	0 Feet²	0 Feet²	
Condition State Quantities				
Condition State 1	Condition State 2	Condition State 3	Condition State 4	
77150 Feet²	6000 Feet²	100 Feet²	0 Feet²	

Element Number	Element Name	Quantity		
1250	Concrete Portal	1100 Feet²		
Inspection Results				
A visual inspection was performed on the concrete slab-on-grade. The inspection results are as follows: South Portal east wingwall has single crack which is 4 feet and length and 0.125 inches wide. No other defects were noted.				
Condition State Defect Assessment				
Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delaminations/ Spalls/ Patched areas	1090 Feet²	0 Feet²	0 Feet²	0 Feet²
Cracking Sizes	0 Feet²	0 Feet²	10 Feet²	
Efflorescence	0 Feet²	0 Feet²	0 Feet²	
Settlement	0 Feet²	0 Feet²	0 Feet²	
Condition State Quantities				
Condition State 1	Condition State 2	Condition State 3	Condition State 4	
1090 Feet²	0 Feet²	10 Feet²	0 Feet²	

Element Number	Element Name	Quantity
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1510	Concrete Slab-on-Grade	54000 Feet²		
Inspection Results				
A visual inspection was performed on the concrete slab-on-grade. The inspection results are as follows: Damage to utility trench paving patch which is located in the SB lane near the south portal. The patch is 5 feet by 2 feet in dimension (10 Feet²). There is 3 inches of settlement and a void up to 7 inches below the patch. No other defects were noted.				
Condition Defect Assessment				
Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Delaminations/ Spalls/ Patched areas	53490 Feet²	0 Feet²	0 Feet²	0 Feet²
Cracking	0 Feet²	0 Feet²	0 Feet²	
Settlement	0 Feet²	0 Feet²	10 Feet²	
Condition State Quantities				
Condition State 1	Condition State 2	Condition State 3	Condition State 4	
53490 Feet²	0 Feet²	10 Feet²	0 Feet²	

Element Number	Element Name		Quantity	
2300	Tunnel Lighting Systems		1 Each	
Inspection Results				
The Tunnel Lighting System was inspected and found to be operating at its capacity.				
Condition State Defect Assessment				
Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
System Operations	1 Each	0 Each	0 Each	0 Each
Condition State Quantities				
Condition State 1	Condition State 2	Condition State 3	Condition State 4	
1 Each	0 Each	0 Each	0 Each	

Element Number	Element Name	Quantity
2301	Tunnel Lighting Fixtures	560 Each
Inspection Results		
The tunnel lighting fixtures are numbered sequentially starting with Lighting Fixture #1 at the south portal and ending with Lighting Fixture 560 at the north portal.		

A visual inspection was performed on the lighting fixtures. The inspection results are as follows:  
Housing or Enclosures: There is no damage to the housing or enclosure of Lighting Fixtures 1 through 560.  
Component Supports: Lighting Fixtures 61 through 65 exhibit minor loss of mounting hardware. There are no deficient support conditions for all other lighting fixtures.  
Component Paint and Corrosion: Lighting Fixtures 61 through 65 exhibit corrosion in excess of 25%. All other lighting fixtures are free from rust and corrosion.

**Condition State Defect Assessment**

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Component Supports	555 Each	0 Each	0 Each	0 Each
Component Paint and Corrosion	0 Each	0 Each	5 Each	0 Each
Component Housing or Enclosure	0 Each	0 Each	0 Each	0 Each

**Condition State Quantities**

Condition State 1	Condition State 2	Condition State 3	Condition State 4
555 Each	0 Each	5 Each	0 Each

Element Number	Element Name	Quantity
2600	Traffic Sign	2 Each

**Inspection Results**

A visual inspection was performed on the traffic sign supports. No defects in the support conditions were observed.

**Condition State Defect Assessment**

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Support condition	2 Each	0 Each	0 Each	0 Each

**Condition State Quantities**

Condition State 1	Condition State 2	Condition State 3	Condition State 4
2 Each	0 Each	0 Each	0 Each

Element Number	Element Name	Quantity
2625	Pedestrian Sign	2 Each

**Inspection Results**

A visual inspection was performed on the pedestrian sign supports. No defects in the support conditions were observed (Condition State 1).				
Condition State Defect Assessment				
Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Support condition	2 Each	0 Each	0 Each	0 Each
Condition State Quantities				
Condition State 1	Condition State 2	Condition State 3	Condition State 4	
2 Each	0 Each	0 Each	0 Each	

## Element Quantity and Condition State Summary

The element quantities and condition states described above are summarized as follows:

Element Number	Element Name	Unit	Quantity	Condition State 1	Condition State 2	Condition State 3	Condition State 4
1000	Cast-in-Place Concrete Tunnel Liner	Feet <sup>2</sup>	18000	13900	4100	0	0
1003	Shotcrete Tunnel Liner	Feet <sup>2</sup>	83250	77150	6000	100	0
1250	Concrete Portal	Feet <sup>2</sup>	1100	1090	0	10	0
1510	Concrete Slab-on-Grade	Feet <sup>2</sup>	54000	53490	0	10	0
2300	Tunnel Lighting Systems	Each	1	1	0	0	0
2301	Tunnel Lighting Fixtures	Each	560	555	0	5	
2600	Traffic Sign	Each	2	2	0	0	0
2625	Pedestrian Sign	Each	2	2	0	0	0

# References

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FHWA Tunnel Operations Maintenance, Inspection and Evaluation (TOMIE) Manual

AASHTO Guide Manual for Bridge Element Inspection, First Edition, 2011

Manual for Uniform Traffic Control Devices (MUTCD), 2009 Edition with Revision Numbers 1 and 2 incorporated, dated May 2012

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